Naval Facilities Engineering Systems Command Southwest
BRAC PMO West
San Diego, CA

Final

Remedial Action ~~Completion~~Construction Summary Report

Parcel E-2 (Phase II)

Hunters Point Naval Shipyard
~~San Francisco, California~~, CA

~~November 2020~~January 2021

Naval Facilities Engineering Systems Command
Southwest
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Naval Facilities Engineering Systems Command

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Acronyms and Abbreviations

^{226}Ra radium-226
^{60}Co cobalt-60
^{137}Cs cesium-137
^{90}Sr strontium-90
API .... American Petroleum Institute
APTIM .... Aptim Federal Services, LLC
bgs .... below ground surface
BMP .... best management practice
BRAC .... Base Realignment and Closure
CB .... cement-bentonite
CB&I .... CB&I Federal Services LLC
CERCLA .... Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC .... chemical of concern
CSO .... Caretaker Site Office
cy .... cubic yard
DBR .... *Final Design Basis Report, Parcel E-2, Hunters Point Naval Shipyard, San Francisco, California*
DQO .... data quality objective
ERRG .... Engineering/Remediation Resources Group, Inc.
FCR .... field change request
FW .... survey unit freshwater
FWV .... field work variance
GSI .... Geo-Solutions, Inc.
HDPE .... high-density polyethylene
HPNS .... Hunters Point Naval Shipyard
HRA .... *Final Historical Radiological Assessment, Volume II, History of the Use of General Radioactive Materials, 1939—2003, Hunters Point Shipyard, San Francisco, California*
IL .... investigation level
LLRO .... low-level radiological object

Acronyms and Abbreviations (continued)

LLRW	low-level radiological waste
msl	mean sea level
NaI	sodium iodide
~~NAVFAC~~	~~Naval Facilities Engineering Command~~
Navy	U.S. Department of the Navy
NRDL	Naval Radiological Defense Laboratory
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram
psi	pound per square inch
QC	quality control
RA	remedial action
RACSR	remedial action ~~completion~~construction summary report
RAMP	Remedial Action Monitoring Plan
RAO	remedial action objective
RASO	Radiological Affairs Support Office
RCT	Radiological Control Technician
~~RIP~~	~~Remedy in Place~~
ROC	radionuclide of concern
ROD	*Final Record of Decision for Parcel E-2, Hunters Point Shipyard, San Francisco, California*
ROI	region of interest
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
RSI	Radiation Solutions Inc.
RSY	radiological screening yard
RWP	radiological work permit
SCB	soil-cement-bentonite
SU	survey unit
TCRA	time-critical removal action
TPH	total petroleum hydrocarbons
VD	virtual detector
Work Plan	*Final Work Plan, Remedial Action, Parcel E-2, Hunters Point Naval Shipyard, San Francisco, California*

1.0 [AUTOTEXTLIST \s"Break"\t"Right-click to change break type" * MERGEFORMAT]Overview

This remedial action ~~completion~~construction summary report (RACSR) presents the specific tasks and procedures implemented by Aptim Federal Services, LLC (APTIM) within Parcel E-2, Hunters Point Naval Shipyard (HPNS), San Francisco, California (Figure 1). The purpose of this RACSR is to demonstrate that the remedial action (RA) was successfully completed in accordance with the following~~, such that the remedial action objectives (RAOs) were achieved~~:

- *Final Record of Decision for Parcel E-2, Hunters Point Shipyard, San Francisco, California* (ROD; Navy, 2012)
- *Final Design Basis Report, Parcel E-2, Hunters Point Naval Shipyard, San Francisco, California* (DBR; Engineering/Remediation Resources Group, Inc. [ERRG], 2014)
- *Final Work Plan, Remedial Action, Parcel E-2, Hunters Point Naval Shipyard, San Francisco, California* (Work Plan; CB&I Federal Services LLC [CB&I], 2016)

The RA was performed for the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command Southwest, under Contract No. N62473-12-D-2005, Contract Task Order 0013. Base Realignment and Closure (BRAC) Program Management Office West managed the work elements under this contract task order.

There are ~~three~~multiple implementation phases of the Parcel E-2 RA as described within the DBR (ERRG, 2014) due to high dollar value of the entire remedy. Each phase of the RA addresses individual components of the remedy that are independent of one another. The task order described within this RACSR was designated as Phase II. The objective of the Phase II RA was to implement a portion of the remedy selected in the ROD (Navy, 2012), specifically the shoreline revetment; site grading and consolidation of excavated soil, sediment, and debris; and upland slurry wall installation. Remaining components of the DBR will be implemented during the final phase of construction, which will be awarded by the Navy under a separate task order.

Previous removal actions include construction of an additional interim Parcel E-2 landfill cap over 14.5 acres of the landfill that was burned in an August 2000 brush fire. Another earlier removal action addressed the "PCB Hot Spot Area" in the east adjacent area that previously contained soil and construction debris prior to the 1950s. Part of the panhandle contained metal slag disposed of by the Navy ("Metal Slag Area") and a different part of the panhandle area is where the Navy tested ship shielding technologies ("Ship Shielding Area"). Both areas were addressed under earlier removal actions.

1.1 Site Location

HPNS is located on a peninsula in southeastern San Francisco that extends eastward into the San Francisco Bay (Figures 1 and 2). Of the 866 acres that compose HPNS, 420 acres are on land and 446 acres are submerged under water in the San Francisco Bay. Parcel E-2 is located in the most northwestern area of HPNS and contains 47.4 acres of shoreline and lowland coast. Parcel E-2 is bounded by property of the University of California, San Francisco to the north, the San Francisco Bay to the south, Parcel E to the east, and non-Navy owned property to the west. Parcel E-2 sits in an area created between the 1940s and 1960s by filling in the San Francisco margin with materials including soil, crushed bedrock, dredged sediments, and debris (CB&I, 2016). Figure 3 shows pre-existing site conditions.

1.2 Site Description and History

The Navy purchased the land portion of HPNS in 1939 and leased it to Bethlehem Steel Corporation. At the start of World War II in 1941, the Navy took possession of the property and operated it as a shipbuilding, repair, and maintenance facility until 1974 when the Navy deactivated HPNS. HPNS was also the site of the Naval Radiological Defense Laboratory (NRDL) from the late-1940s until 1969. From 1976 to 1986, the Navy leased HPNS to Triple A Machine Shop, Inc., a private ship repair company. In 1986, Triple A Machine Shop, Inc. ceased operations, and the Navy resumed occupancy through 1989. In 1991, HPNS was placed on the Navy's BRAC list, and its mission as a shipyard ended in April 1994. The *Final Historical Radiological Assessment, Volume II, History of the Use of General Radioactive Materials, 1939—2003, Hunters Point Shipyard, San Francisco, California* (HRA; Naval Sea Systems Command, 2004) gives a history of Navy radiological operations at HPNS (CB&I, 2016). The following radiological operations were identified at Parcel E-2:

- Dials, gauges, and deck markers painted with radioactive paint containing low levels of radium-226 (^{226}Ra) were disposed of at the Parcel E-2 landfill, portions of the panhandle area, and the east adjacent area (CB&I, 2016).
- Small amounts of low-level radionuclides may be present in drain lines in the eastern part of Parcel E-2. Potential release of low-level radionuclides into drain lines at former NRDL buildings located outside of Parcel E-2 in Parcel E may have led to drain lines in the eastern part of Parcel E-2. The drain lines in Parcel

E and contamination within are currently being excavated as part of an ongoing RA being performed throughout HPNS (CB&I, 2016).

- Materials used during radiological experiments by NRDL may have been disposed of at the Parcel E-2 landfill and portions of the panhandle and east adjacent area. The HRA suggests that such material was strictly controlled particularly after 1954 when the U.S. Atomic Commission began regulating the use of radionuclides at HPNS. The potential volume of NRDL waste disposed of at the Parcel E-2 landfill is low, as these areas were filled after 1955 (CB&I, 2016).
- Sandblast waste from cleaning ships used during weapons testing in the South Pacific may have been disposed of at Parcel E-2 landfill, the panhandle area, and the east adjacent area. The HRA suggests that the sandblast waste with highest levels or radioactivity was controlled and not disposed of within HPNS (CB&I, 2016).

HPNS was placed on the National Priorities List in 1989 pursuant to Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986, because past shipyard operations left hazardous substances on site. HPNS was designated for closure in 1991 pursuant to the Defense Base Closure and Realignment Act of 1990. Closure involves conducting environmental remediation and making the property available for nondefense use (CB&I, 2016).

The Parcel E-2 landfill is 22 acres in size and contains various shipyard wastes disposed of by the Navy from the mid-1950s to the early 1970s. Waste included construction debris; municipal-type trash; and industrial waste including sandblast waste, radioluminescent devices, paint sludge, solvents, and polychlorinated biphenyl (PCB)-containing waste oils. After closure of the landfill in the early 1970s, it was covered with 2 to 5 feet of soil by the Navy. The estimated volume of waste in the landfill is 473,000 cubic yards (cy) (CB&I, 2016).

Fill materials in the east adjacent, panhandle, and shoreline areas of Parcel E-2 are distinct from the Parcel E-2 landfill area. Figure 2 presents these areas. Fill materials in the east adjacent, panhandle, and shoreline areas primarily consist of soil, sediment, and rock with isolated solid waste locations that are not contiguous with solid waste in the landfill, as described (CB&I, 2016):

- The east adjacent area was created prior to the 1950s by filling in San Francisco Bay with soil and construction debris. Some industrial waste was disposed of in parts of the east adjacent area, including a PCB Hot Spot Area, which was addressed under an earlier RA (CB&I, 2016).

- The panhandle area was created in the 1950s by filling in San Francisco Bay with soil and construction debris. The Navy disposed of metal slag in an area referred to as the "Metal Slag Area." The Navy also tested ship shielding technologies in another area referred to as the "Ship Shielding Area." These two areas were addressed under earlier RAs (CB&I, 2016).
- The shoreline area is adjacent to the San Francisco Bay and contains contaminated sediment above mean sea level (msl).

1.3 Topography and Site Features

Prior to implementation of this RA, the ground surface elevation of Parcel E-2 ranged from approximately 30 feet above msl in the northern portion of Parcel E-2, to a few feet above msl along the southwest portion of Parcel E-2 (Figure 3). Surface runoff from most of the parcel flowed directly into the San Francisco Bay with the exception of runoff in the northern portion of the parcel, which flowed into catch basins which discharge into the HPNS storm sewer system and then into the San Francisco Bay (CB&I, 2016).

1.4 Climate

The climate around HPNS is characterized as partly cloudy, cool summers with little precipitation, and mostly clear, mild winters with moderate precipitation. Average temperatures vary from 50 to 60 degrees Fahrenheit, and the average humidity varies from 70 to 75 percent. Prevailing winds in the area are out of the west, west-northwest, and west-southwest. Wind strength and direction vary seasonally. Winds at HPNS are generally strongest in the mid-to-late afternoon hours, when high winds tend to blow in from the Pacific Ocean. Wind speeds average around 8 miles per hour, and wind gusts may exceed 25 miles per hour (CB&I, 2016).

1.5 Parcel E-2 Geology

The geology at the surface of Parcel E-2 consists of artificial fill material, which may contain serpentine bedrock, excavated Bay Mud, sands, gravels, construction debris, industrial debris, and sandblast waste (CB&I, 2016).

1.6 Parcel E-2 Hydrogeology

Groundwater at Parcel E-2 is present in the A-aquifer, B-aquifer, and bedrock water-bearing zone. The A-aquifer consists primarily of saturated artificial fill. The groundwater in the A-aquifer is present from 1 to 15 feet below ground surface (bgs), with generally higher groundwater levels during the wet season in winter and spring (CB&I, 2016). Additional information regarding Parcel E-2 groundwater can be found in the *Final Remedial Investigation/Feasibility Study Report for Parcel E-2 Hunters Point Shipyard San Francisco, California* (ERRG, 2011).

1.7 Parcel E-2 Hydrology

The main source of surface water runoff at HPNS is precipitation. Surface water runoff is greatest in the winter months, November through April. During this time, rainfall often exceeds 4 inches per month. Minimal runoff occurs from June through September, when precipitation is typically less than 0.1 inch per month (CB&I, 2016).

1.8 Chemicals and Radionuclides of Concern

Various chemicals of concern (COCs) and radionuclides of concern (ROCs) exist for the soil, shoreline sediment, groundwater, and landfill gas at HPNS.

1.8.1 Soil

The COCs in soil at Parcel E-2 include metals (antimony, arsenic, cadmium, copper, iron, lead, manganese, mercury, nickel, vanadium, and zinc), pesticides, PCBs, semivolatile organic compounds, total petroleum hydrocarbons, dioxins, and radionuclides. The ROCs are cesium-137 (^{137}Cs), cobalt-60 (^{60}Co) in the experimental Ship Shielding Area only, ^{226}Ra, and strontium-90 (^{90}Sr) (CB&I, 2016).

1.8.2 Shoreline Sediment

The COCs in the shoreline sediment at Parcel E-2 include metals (antimony, copper, lead, mercury, nickel, and zinc), pesticides, PCBs, and radionuclides (^{226}Ra, ^{137}Cs, and ^{90}Sr) (CB&I, 2016).

1.8.3 Groundwater

The COCs in groundwater at Parcel E-2 include metals (antimony, chromium VI, iron, lead, and thallium), pesticides, PCBs, semivolatile organic compounds, total petroleum hydrocarbons (TPH), volatile organic compounds, anions (such as cyanide, sulfide, and un-ionized ammonia), and radionuclides (^{226}Ra, ^{137}Cs, and ^{90}Sr) (CB&I, 2016).

1.8.4 Landfill Gas

The COCs in landfill gas at Parcel E-2 include methane and volatile organic compounds (CB&I, 2016).

1.9 Previous Removal Actions

Several CERCLA removal actions and other interim actions have been performed at Parcel E-2 in the past. A brush fire occurred on August 16, 2000, that burned 45 percent (approximately 14.5 acres) of the landfill surface area. The surface fire was extinguished quickly, but small subsurface fires persisted for approximately 1 month. A time-critical removal action (TCRA) was performed from 2000 to 2001 to construct an interim cap to extinguish the fire and prevent the occurrence of future fires underneath the capped area (Navy, 2012).

From 2002 to 2003 a TCRA was conducted to address the explosion hazards and human health risks associated with the off-site migration of landfill gas. The TCRA consisted of the installation and operation of a gas control, extraction and treatment system (Navy, 2012).

From June 2005 to May 2006, a TCRA was performed at the Metal Slag Area. This TCRA removed metal slag and debris containing low-level radiological material and other incidental chemical contamination. Approximately 8,200 cy of contaminated soil and sediment, 119 cy of which contained radionuclides, were excavated from this area in the southwest portion of the panhandle area (Gilbane Federal, 2017).

A Phase 1 TCRA was performed in the PCB Hot Spot Area from June 2005 to September 2006 to remove contaminated soil and debris possibly containing low-level radiological material. Free-phase petroleum hydrocarbons were also removed to the extent practical. Approximately 44,500 cy of contaminated soil, 611 cy of which contained radionuclides, were excavated from this area in the southeast portion of Parcel E-2 (Gilbane Federal, 2017).

A Phase 2 TCRA was performed at the PCB Hot Spot Area from March 2010 to November 2012 to remove contaminated soil and debris from the shoreline portion of the PCB Hot Spot Area, and other hot spots identified in the Remedial Investigation/Feasibility Study Report. Approximately 42,200 cy of contaminated soil and 6,000 cy of large debris were excavated from areas not addressed during the Phase 1 TCRA (Gilbane Federal, 2017).

A TCRA was performed at the Ship Shielding Area from May 2012 to October 2012 to remove soil and debris potentially containing low-level radiological material containing ^{60}Co in the southwestern portion of the panhandle area. Approximately 3,800 cy of soil, 120 cy of which contained radionuclides, were excavated. ^{60}Co was not identified at levels exceeding the remediation goals, however, final surveys of the ground surface indicated ^{137}Cs and ^{90}Sr activity levels that exceeded remediation goals. Further remediation of this area was designated to be performed later (Gilbane Federal, 2017).

From November 2014 to March 2016, approximately 39,004 cy of contaminated soil were excavated from the PCB Hot Spot Area within the upland area and along the shoreline of the bay. Approximately 5,324 cy of soil and debris were excavated prior to installation of the nearshore slurry wall, and 3,499 cy of material were trenched during the nearshore slurry wall installation. Materials were screened for radiological contamination. The nearshore slurry wall was successfully installed during these efforts (Gilbane Federal, 2017).

1.10 Report Organization

This RACSR consists of nine sections and is organized as follows:

- Section 1.0, "Overview"—Section 1.0 provides an overview of the project, discusses site conditions and background, chemicals and ROCs, previous removal actions, and the RACSR organization.
- Section 2.0, "Remedial Action Objectives"—Section 2.0 presents the remedial action objectives (RAOs) for this RA.
- Section 3.0, "Remedial Actions"—Section 3.0 describes the RA pre-construction and construction remedial activities, including waste characterization and management, site surveys, and deviations from the planning documents.
- Section 4.0, "Demonstration of Completion"—Section 4.0 provides information to demonstrate completion of the Parcel E-2 Phase II RA described herein ~~and the achievement of the RAOs for soil and solid waste that were identified in the ROD.~~.
- Section 5.0, "Data Quality Assessment"—Section 5.0 discusses the findings of the data review and validation process for analytical and radiological data.

- Section 6.0, “Community Relations”—Section 6.0 describes the community involvement activities associated with this RA.
- Section 7.0, “Conclusions and Ongoing Activities”—Section 7.0 provides conclusions following completion of the RA for Parcel E-2 and discusses activities currently ongoing at Parcel E-2 to maintain the remedy.
- Section 8.0, “Certification Statement”—Section 8.0 presents the RACSR certification statement.
- Section 9.0, “References”—Section 9.0 includes a list of documents used to compile this RACSR.

The following are included as Appendices A through AA, respectively:

- Responses to Agency Comments
- Pre-Final and Final Inspection Checklist
- Construction As-Built Drawings
- Unexploded Ordinance Data
- Low-Level Radiological Waste Manifests
- Monitoring Well Network
- Field Change Requests
- Surveyor Submittals
- Photograph Log
- Low-Level Radiological Objects
- Slurry Wall Field Reports and Testing Results
- RESRAD Modeling
- Quality Control Testing Results
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2.0 [AUTOTEXTLIST \s"Break"\t"Right-click to change break type" * MERGEFORMAT]Remedial Action Objectives

The RAOs were established in the ROD (Navy, 2012) and are based on the following:

- Attainment of regulatory requirements, standards, and guidance
- Contaminated media
- COCs and chemicals of ecological concern
- Potential receptors and exposure scenarios
- Human health and ecological risks

RAOs for Parcel E-2 are based on future open space reuse. The Navy is not seeking free radiological release of Parcel E-2 at this time (CB&I, 2016).

The soil and sediment RAOs that apply for this RA are listed as follows:

- Prevent human exposure to inorganic and organic chemicals at concentrations greater than remediation goals (Table 1) for the following exposure pathways:
  - Ingestion of, outdoor inhalation of, and dermal exposure to solid waste, soil, or sediment from 0 to 2 feet bgs by recreational users throughout Parcel E-2.
- Prevent ecological exposure to concentrations of inorganic and organic chemicals in solid waste or soil greater than remediation goals (Table 1) from 0 to 3 feet bgs by terrestrial wildlife throughout Parcel E-2.

- Prevent ecological exposure to concentrations of inorganic and organic chemicals in solid waste or soil greater than remediation goals (Table 1) from 0 to 3 feet bgs by aquatic wildlife throughout the shoreline area.
- Prevent exposure to ROCs at activity levels that exceed remediation goals (Table 2) for potentially complete exposure pathways.

The control of groundwater via the upland slurry wall and French drain, and by other remedies such as the nearshore slurry wall and upgradient well network, will address the groundwater RAOs:

- Prevent or minimize migration of chemicals of potential ecological concern to prevent discharge that would result in concentrations greater than the corresponding water quality criteria for aquatic wildlife.
- Prevent or minimize migration of A-aquifer groundwater containing total TPH concentrations greater than the remediation goal (where commingled with CERCLA substances) into the San Francisco Bay.

3.0 [AUTOTEXTLIST \s "Break" \t "Right-click to change break type" * MERGEFORMAT]Remedial Action

This section discusses the RAs what were conducted under this task for Parcel E-2 (Phase II). Background information and data related to the RAs are presented in the appendices to this RACSR, as given in the following subsections. Appendix I presents photographs taken during the various stages of the RA.

3.1 Pre-Construction Activities

Pre-construction activities included permitting and notifications, meetings, biological surveying and monitoring, topographical surveys, utility surveys, and site preparation. The following subsections describe the activities that were performed in preparation for remediation work.

3.1.1 Permitting and Notifications

APTIM obtained necessary authorizations from the HPNS Caretaker Site Office (CSO) and the Resident Officer in Charge of Construction (ROICC) for performing the RA at Parcel E-2. Prior to field activities, APTIM notified the Navy Remedial Project Manager (RPM), ROICC, CSO, appropriate fire department personnel, and HPNS security as to the nature of the anticipated work.

The work was conducted in accordance with Section 121(e) of CERCLA (42 United States Code, Section 9621[e]), as amended, which states that no federal, state, or local permits will be required for the portion of removal or RA conducted entirely on site. Because this work was executed to support a RA and was conducted entirely on site, no other permits and fees were required for the RA. However, substantive provisions of applicable or relevant and appropriate requirements specified in the ROD (Navy, 2012) were fulfilled.

APTIM maintains a current annual excavation permit from the California Occupational Safety and Health Administration (Permit No. 2015-917213). Where required, 24-hour notification was provided before excavation activities began. Underground Service Alert (800 227 2600) was notified to obtain utility clearance a minimum of 72 hours prior to intrusive activities. The permits and notifications were maintained for the duration of the field activities.

Radiological work permits (RWPs) were prepared in accordance with AMS-710-07-WI-04009, “Radiological Work Permits” (APTIM, 20~~19~~20), as applicable, to address the activities performed in radiological areas and included radiological conditions and safety requirements for the activities. Personnel assigned to site work were required to read and sign the RWP acknowledging that they understand the requirements of the RWP prior to beginning work. The RWPs identify the requirements for entering, exiting, and conducting work in radiologically posted areas.

3.1.2 Pre-Construction and Kickoff Meetings

A project kickoff meeting was held on September 10, 2015. Attendees included the Navy RPM, the ROICC, and APTIM personnel. The purpose of the meeting was to review the project description and objections, discuss logistics and site access, introduce the team, and review project organization and schedule.

Prior to the start of field activities, a pre-construction and mutual understanding meeting was held on July 26, 2016. Personnel attending the meeting included representatives of APTIM, the Navy RPM, the Navy ROICC, the Navy HPNS CSO, and other contracted personnel. The purpose of this meeting was to develop a mutual understanding of the remedial activities and the contractor quality control (QC) details, including forms to be used, administration of on-site work, and coordination of the construction management and production.

Upon receipt of the appropriate authorizations, field personnel, temporary facilities, and construction materials were mobilized to the jobsite on August 2, 2016. Dedicated laydown areas established in the field during mobilization, were used for short-term storage of equipment and materials. Additional pre-construction meetings were held with appropriate field personnel, subcontractors, and Navy representatives at the beginning of each definable feature of work, as specified in the contractor QC plan (Work Plan Appendix E; CB&I, 2016).

3.1.3 Construction Quality Control Meetings

Contractor QC meetings were held on a weekly basis throughout the course of fieldwork. At a minimum, the Project QC Manager with the Construction Manager, Radiological Control Supervisor, and the field foremen attended this meeting. The Navy RPM, ROICC, CSO, and other site personnel, subcontractor, and vendor representatives attended in person or via phone as appropriate. Appendix O includes weekly project QC meeting minutes.

3.1.4 Health and Safety Meetings

Daily tailgate safety meetings were held each morning prior to starting work. Construction staff, including subcontractors, attended these meetings and signed a tailgate safety meeting form. The meetings were held by the Site Safety and Health Officer and covered various safety issues. Subcontractor, inspector, agency, or Navy personnel that visit the site during the course of the day was required to review and sign the tailgate form prior to entering the work site.

3.1.5 Biological Surveying and Monitoring

A pre-construction biological survey was performed prior to implementing this RA at Parcel E-2 to address the following:

- Identifying potential bird species that are protected under the Migratory Bird treaty Act (16 United States Code Section 703) and California Fish and Game Code Section 3511 and, if such species are present, specify reasonable measures to ensure their adequate protection during implementation of the remedy.
- Determine the extent to which the wetlands restoration for the Yosemite slough restoration project may have attracted endangered or fully protected bird, mammal, amphibian, or reptile species (as identified in pertinent sections of the California Fish and Game Code) and, if such species are present, specify reasonable measures to ensure their adequate protection during implementation of this Work Plan (CB&I, 2016).

Biological monitoring and reporting were performed by a qualified biologist during mobilization, demobilization, grading, excavation, and shoreline revetment installation activities in accordance with the biological surveying and monitoring plan (Work Plan Appendix A; CB&I, 2016). Appendix T includes results of the biological surveys and daily biological inspections.

3.1.6 Topographical Survey

A pre-construction topographic survey was completed by Bellecci & Associates, Inc., under the direction of a State of California-licensed land surveyor, on April 27, 2016. Data from this survey were used to establish horizontal and vertical controls for the site, and to assess the pre-RA site topographic features, such as high points and low points. Appendix C provides the pre-construction topographic survey.

3.1.7 Utility Survey

Underground Service Alert North was contacted on August 2, 2016, before site activities were initiated, to locate publicly and privately-owned underground utilities. From August 8 through August 10, 2016, a geophysical utility survey was conducted using magnetic and electromagnetic techniques across the Parcel E-2 project site. No subsurface utilities were identified during the survey.

3.1.8 Site Preparation

Parcel E-2 work areas were protected against stormwater pollution through installation and maintenance of best management practices (BMPs), as described in the environmental protection plan (Work Plan Appendix D; CB&I, 2016). BMPs were implemented for sediment control, to minimize erosion, for tracking control, and for waste management control. Straw wattles were installed as the primary BMP for this RA to prevent stormwater on the contaminated portion of the site from leaving the site, as well as to prevent stormwater run-on from areas outside of the site. Sandbags were placed as needed in drainage control swales and at drainage control discharge points or areas with a high probability of erosion.

In accordance with the DBR (ERRG, 2014), a 2,000-foot U.S. Department of Transportation Type III offshore turbidity curtain was deployed into the San Francisco Bay for the excavations within the intertidal zone on November 30, 2016. Prior to shoreline construction activities (excavation, backfilling, and restoration), water quality monitoring for dissolved oxygen, pH, and turbidity, as well as collecting a water sample for dissolved metals, pesticides, PCBs, and gamma spectroscopy analysis, will be performed daily for a three-day period at the point of compliance (20 feet outside the turbidity curtain centrally located within the area where the turbidity curtain is anticipated to be installed). These samples will be used to establish background values in conjunction with data from previous removal and RAs at HPNS.

During shoreline construction activities (excavation, backfilling, and restoration), water quality monitoring was performed daily for dissolved oxygen, pH, and turbidity. Weekly grab samples were also collected and analyzed for metals, pesticides, PCBs, and ROC. Sampling procedures and analytical requirements were in compliance with the environmental protection plan (Work Plan Appendix D; CB&I, 2016). Appendix Y presents sample results and monitoring logs.

Dust control measures were implemented during activities involving soil disturbance or soil handling by continuously wetting the work areas in accordance with the environmental protection plan (Work Plan Appendix D; CB&I, 2016).

3.2 Phase II Remedial Activities

This subsection describes the methods and procedures that were used to complete the following Phase II construction RAs. The completed RAs were implemented in accordance with the approved Work Plan (CB&I, 2016~~)~~), except as noted herein, and included the following:

- Shoreline revetment construction
- Site grading and on-site consolidation
- Upland slurry wall and French drain installation
- Final radiological characterization survey
- Construction of foundation soil layer
- Installation of monitoring/extraction wells and piezometers
- Waste management
- Final topographic survey
- Decontamination and release of equipment and tools
- Deconstruction of radiological screening yard (RSY) pads
- Demobilization

Excavation, grading, and subsurface work was performed under unexploded ordinance construction oversight in accordance with the *Explosives Safety Submission Determination Request for the Shoreline Revetment, Site Grading and Consolidation of Excavated Soil, Sediment, and Debris, and Upland Slurry Wall, Remedial Action at Parcel E-2, Hunters Point Naval Shipyard, San Francisco, California* (Navy, 2015). Construction activities were implemented in accordance with the DBR design drawings (DBR Appendix B; ERRG, 2014) and project specifications (DBR Appendix C; ERRG, 2014).

3.2.1 Shoreline Revetment

The shoreline revetment was constructed in accordance with the Work Plan (CB&I, 2016) and as described in Sections 3.2.2 through 3.2.9.

3.2.2 Excavation of Offshore Soil and Sediment from Parcel F

To assure the integrity of the revetment structure during future remediation activities within the San Francisco Bay, additional excavations were performed into Parcel F (just outside the Parcel E-2 shoreline) prior to installation of the shoreline revetment. The excavation extended a minimum of 6 feet offshore of the proposed revetment toe to depths ranging from 1.5 to 2.5 feet bgs (As-built Drawing C2; Appendix C). Following each excavation, the wedge of material removed was backfilled using approved material imported to the site. Shoreline excavations were conducted in workable segments perpendicular to the shoreline using a Hyundai 290 long-reach excavator. A single segment was limited to the extent of shoreline, which could be completed (excavated and backfilled) within a single low tidal cycle, thus minimizing potential impact to the San Francisco Bay during construction. Excavated material from Parcel F was segregated and tracked separately from the Parcel E-2 excavation. The sampling and analysis plan (Work Plan Appendix B; CB&I, 2016) provides analytical requirements and procedures for clean fill import verifications. Appendix W provides the import material approval packages.

In situ radiological gamma surface surveys were not performed in saturated and/or underwater areas of the Parcel F excavation. Saturated soil excavated from the intertidal zone was placed in plastic lined drying cells constructed adjacent to the excavation areas. These cells were constructed to allow water to drain from the soil and into the excavation from which it was removed. Once the material was dry, it was loaded into haul trucks and transported to the RSY pads for radiological screening, as described in Section 3.3. The estimated volume of material excavated and subsequently backfilled within the Parcel F revetment toe was approximately 666 cy.

3.2.3 Upland Excavation

Soil and debris within the upland (unsaturated) area was excavated to geogrid limits shown on As-built Drawing C2 (Appendix C) to a minimum elevation of 6.5 feet above msl. The upland excavation included excavations above msl to establish the subgrade elevation for the shoreline revetment sub-construction and geogrid placement. The excavation limits and subgrade elevations were marked out in the pre-construction survey to indicate the prescribed depths required for the subgrade. Prior to commencing excavation, surface debris including rocks, concrete (temporary revetment), rebar, metal debris, wood and other refuse were removed and staged for on-site consolidation, as described in Section 3.2.12.

The excavations were completed in 12-inch lifts. Following each lift, a Radiological Control Technician (RCT) performed a radiological gamma surface survey of in situ unsaturated soil to identify and allow removal of potential contamination and/or low-level radiological objects (LLROs) as soil was excavated. Following the identification and removal of radiological materials, if present, another 12-inch lift was excavated. This process of radiological surface screening before each 12-inch lift was repeated in unsaturated soil areas until the target depth was achieved. Large-size subsurface debris, such as concrete slabs, steel, and wood, were segregated from the soil during excavation for ex situ radiological screening and processing. To minimize the potential for dust, a water truck equipped with a hose was used to mist the dry soil and debris during excavation and segregation.

Excavated soil was loaded directly onto haul trucks and placed on RSY pads for radiological processing, as described in Section 3.3. Excavated soil was not transported on shipyard roadways outside the Parcel E radiologically posted work area. Figure 4 shows the layout of the RSY pad area.

3.2.4 Geogrid Installation

After the subgrade was established and final radiological characterization surface surveys were complete, the geogrid layer (Tencate Miragrid® 22XT) was installed as continuous strips of material running perpendicular to the revetment slope, installed from the upland anchor point to the base of the revetment toe. Each strip of geogrid was installed in accordance with the design specifications as provided in the DBR (Appendix C Section 31 05 21 [ERRG, 2014]). Per the project requirements, each strip of geogrid was cut to length and placed as a single strip of material with minimal overlapping and no splicing. To help protect the geogrid, each strip of material was placed from the upland anchor point and unrolled towards the shoreline, where the final approximate 35 feet of geogrid remained unrolled above the mean high tide line. Only sections being currently installed would be fully unrolled to their design length. As sections were installed along the upland side, radiologically-cleared fill material was placed and compacted over the geogrid to match the elevation of the final cover (approximately 9 feet above msl). Fill material was pushed out over the geogrid in an upward tumbling motion to prevent wrinkles in the geogrid from folding over. Driving over the geogrid was prohibited until a minimum of 1 foot of soil cover had been placed above the geogrid layer. The final surveyed location of the geogrid layer is shown on As-built Drawing C2 (Appendix C).

The approved geogrid product data sheets and test reports were presented to the Navy in Construction Submittal #014 (Appendix P).

3.2.5 Sheet-pile Management

Protrusions within the geogrid limits were required to be cut to allow for a minimum of one foot of clearance below the final geogrid elevation. This included the temporary shoring, in the form of cantilevered ultra-composite fiberglass-reinforced plastic sheet pile, installed along the length of the Parcel E-2 shoreline by a previous (Phase I) contractor. A gas-powered chop saw was used to cut the temporary shoring wall to an elevation no higher than 3.5 feet above msl. Disturbance of the fiberglass-reinforced plastic sheet pile was initiated only after backfilling on the bay side was partially completed, to an elevation of at least 3 feet above msl, to minimize influence on the stability of the existing nearshore slurry wall. Removed portions of the sheet-pile wall were stacked in an upland area for radiological screening and disposal, as discussed in Section 3.2.12.

While performing planned subgrade excavation activities within the shoreline survey units (SUs) (Section 3.2.10), a steel sheet-pile wall was encountered approximately 1 foot below existing grade. The location and depth of this steel sheet-pile wall was determined to impact the placement of the scoped geogrid and associated anchor, thus a plan was put in place to over-excavate soil on either side of the steel sheet-pile wall to approximately 1.5 feet below the design subgrade elevation so that the steel sheet-pile wall could be cut down to the required 1 foot of clearance. The material from the excavation was transported to an RSY pad for processing while the top portion of the steel sheet-pile wall was cut using a plasma cutting tool that had been pre-tested and approved by the Navy for use in this application. Once the sheet-pile sections had been removed, the excavation foot print (sidewalls and bottom) were scanned and sampled to ensure that no radiological contamination was present. The excavation was then backfilled and compacted to the planned subgrade elevation and the removed portions of steel sheet-pile wall were surveyed for radiological release in accordance with Section 3.4.4.

3.2.6 Shoreline Excavation

In order to properly set the stone revetment along the Parcel E-2 shoreline, a keyway was first excavated from the toe of the revetment, sloped upland approximately equal to 3H:1V (1 foot of vertical rise for each 3 feet of horizontal run) from an elevation of 4.5 feet below msl to 4.5 feet above msl. Shoreline excavations were conducted in workable segments perpendicular to the shoreline using a Hyundai 290 long-reach excavator founded on the previously completed upland geogrid anchor. A single segment was limited to the extent of shoreline which could be completed (excavated and restored) within a single low tidal cycle, thus minimizing potential impact to the San Francisco Bay during construction. Saturated soil excavated from the intertidal zone was placed in plastic lined drying cells constructed adjacent to the excavation areas. These cells were constructed to allow water to drain from the soil and into the excavation from which it was removed. Once the material was dry, it was loaded into haul trucks and transported to the RSY pads for radiological screening, as described in Section 3.3. Excavation of the slope for the shoreline revetment area generated approximately 5,110 cy of sediment and debris.

3.2.7 Revetment Material Installation

Following each section of shoreline excavation, the remaining section of geogrid was unrolled from the terminus of the upland anchor to the toe of the completed keyway. Once the geogrid layer was fully installed and anchored, the excavated section of shoreline was restored with revetment material in accordance with DBR Specification 35 31 19 (ERRG, 2014). As designed, the revetment material consisted of a layer of filter fabric, followed by two layers of fragmented rock, placed independently, to provide slope stability in accordance with the DBR. The filter fabric (Mirafi 1100N), similar to the geogrid, was installed perpendicular to the shoreline only with a 2-foot overlap between each panel. The filter fabric terminated within the riprap revetment layer similar to what is shown on As-built Drawing C3 (Appendix C).

With the filter fabric in place, the initial layer of rock, designated as the filter stone layer, was installed. The filter stone layer consisted of a 1 foot 7-inch layer of filter rock, meeting DBR Specification 35 31 19 Section 2.1.3, “Filter Stone” (ERRG, 2014). Once the filter stone layer was in place, the armor stone layer was placed directly over the top. The armor stone layer consisted of a 2-foot, 10-inch layer of riprap, meeting DBR Specification 35 31 19 Section 2.1.2, “Riprap Armor Stone” (ERRG, 2014). During the installation of the armor stone, the filter fabric layer was tied into the rip rap to ensure its stabilization along the slope (top and toe).

The final revetment structure as installed is approximately 35 feet wide with a crest elevation 9 feet above msl (As-built Drawing C3; Appendix C). Approximately 2,755 tons of filter stone and 5,625 tons of armor stone was used to complete installation of the shoreline revetment at Parcel E-2. The approved riprap product data sheets and test reports were presented to the Navy in Construction Submittal #015 (Appendix P).

Appendix I includes photographic documentation of these activities.

3.2.8 Seawall and Headwall Construction

A 3-foot-tall concrete seawall was constructed at the crest of the revetment to increase the wave runup protection level along the Parcel E-2 shoreline. The goal of the concrete seawall is to protect against additional wave runup from the design storm conditions and was proposed as an alternative to placing additional soil and armor rock to reach a final design elevation of 12-feet above msl.

Yerba Buena Engineering & Construction, Inc., out of San Francisco, California, was contracted by APTIM to provide concrete services for the Parcel E-2 RA. As constructed, the concrete seawall was 1,778 feet long and has a T-profile, as shown in DBR Design Drawing S1 (ERRG, 2014). Footings were placed over an approved compacted layer of aggregate base, as specified in DBR Design Drawing S1. Care was taken during placement of the bedding material to not damage the underlying geogrid layer. The concrete seawall was reinforced using steel rebar in compliance with Technical Specification 03 30 00, "Cast-in-place Concrete," and Transmittal #003 (Appendix P) and was formed using concrete with a minimum design strength of 5,000 pounds per square inch (psi). Concrete test cylinders were collected in accordance with ASTM C31 at the frequency listed in the project specifications (ERRG, 2014). Performance testing in accordance with ASTM C39 was used to verify that the strength met the design strength. A total of 57 cylinders were tested after a 28-day curing period, demonstrating an average strength of 6,948 psi with a low of 5,590 psi. Appendix M presents verification of the design concrete strength.

A concrete headwall was constructed adjacent to the revetment structure where water from the freshwater wetlands will discharge through a solid wall high-density polyethylene (HDPE) pipe into the San Francisco Bay. As-built Drawing C2 (Appendix C) identifies the location of concrete headwall structure (which is called out as the "Freshwater Wetland Outfall"). The concrete headwall is required so that adequate cover can be placed over the pipe leading from the freshwater wetlands to the outfall without steepening the surrounding slopes, and to connect into a cut-off wall, which will prevent undercutting below the downstream face of the concrete headwall footing due to scour. The concrete headwall was completed to allow for two separate pipe penetrations which will be installed during a separate phase of the RA.

Appendix I includes photographic documentation of these activities.

3.2.9 Perimeter Channel Outlet Pipe

A perimeter channel outlet pipe was installed through the concrete seawall, running beneath the geogrid liner in accordance with the DBR (ERRG, 2014). The location of the pipe is shown on As-built Drawing C2 (Appendix C). The 20-inch DR17 solid wall HDPE pipe was installed at the elevations provided in the DBR. In accordance with Design Drawing C21 (ERRG, 2014), the pipe was installed through the previously installed nearshore slurry wall, extending inland to the outlet location (to be installed during a separate phase of the RA). The pipe ends were temporarily capped until the remainder of the outlet structure is installed. Where the outfall pipe passed through the nearshore slurry wall cap, bedding material consisting of silty, clayey sand with gravel (Bernard Pile [Appendix M]) was used during restoration of final grade to maintain integrity of the buried pipe beneath the future service road.

3.2.10 Site Grading to Final Subgrade

Site grading was performed across much of Parcel E-2, including the landfill, site perimeter, upland panhandle area, and east adjacent area to establish the subgrade for the designed protective covers, as shown on Design Drawing C12 (ERRG, 2014). Excavations were completed in 12-inch lifts. Following each lift, an RCT performed a radiological surface survey of in situ unsaturated soil to identify and allow removal of potential contamination and/or LLROs as soil was excavated, as described in Section 3.2.11. Following the identification and removal of radiological objects, if present, another 12-inch lift was excavated. This process of surface screening before each 12-inch lift was repeated in unsaturated soil until the target subgrade elevation was achieved. ~~18 LLRO's~~Eighteen LLROs were identified and removed during this surface screening process. Within the Parcel E-2 landfill SUs, the bulk of the subgrade preparation consisted of stripping 1 foot of soil from above the existing soil cover including removal of the pre-existing rock lined swale, without damaging the existing protective liner. Design Drawing C12 (ERRG, 2014) shows the extents of the grading required to prepare the subgrade across the remainder of the site. Large-size subsurface debris such as concrete slabs, steel, and wood were segregated from the soil during excavation for ex situ radiological screening and processing. To minimize the potential for dust, a water truck equipped with a hose was used to mist the dry soil and debris during excavation and segregation.

Excavated soil was loaded directly onto haul trucks and placed on RSY pads for radiological processing, as described in Sections 3.3. Figure 4 shows the layout of the RSY pad area.

Subgrade excavation volumes were estimated daily by counting the number of truckloads that were excavated and staged for radiological processing. In addition, subgrade excavation activities were documented through topographic surveys (before and after excavation). Once the final design subgrade contours were met, a final volume estimate was calculated using Autodesk Civil 3D software. Based on the final survey, a total measured volume of 112,873 cy of waste and soil was generated for reuse on the site. A graphical representation of the final subgrade cut volumes, by area, is shown on As-built Drawing C5 (Appendix C).

3.2.10.1 Excavation to Construct Future Wetlands

The tidal and freshwater wetland areas were excavated and graded to the subgrade design as specified in the DRB (ERRG, 2014). Approximately 51,902 cy of soil, sediment and debris was excavated and radiologically screened from the tidal and freshwater wetland, as shown on As-built Drawing C5 (Appendix C). In accordance with the Work Plan Section 7.2.1.1 (CB&I, 2016), post-excavation soil samples were collected following completion of the planned freshwater and tidal wetland excavation activities. Chemical soil samples were collected within the future wetlands because these areas are not intended to be covered with a final protective liner and infiltration through any contamination may contribute to potential groundwater contamination. Therefore, soil samples were collected after radiological screening of the area at a rate of one sample per 50 feet of sidewall length and one bottom sample for every 2,500 square feet (50-foot by 50-foot grid) of the excavation floor. Whenever an excavation extended deeper than 5 feet, one additional sidewall sample was collected. Comparison results were used to identify additional hot spots, if present.

For every proposed bottom and sidewall confirmation sample location, a soil sample was collected and sent to an off-site laboratory for total copper, total lead, polychlorinated biphenyls and total petroleum hydrocarbons analysis. Analytical results were compared to the appropriate hot spot goals (Tiers 1, 2, and 4) listed in the ~~CB&I Federal Services LLC (October 2016) *Final Work Plan, Remedial Action, Parcel E-2, Hunters Point Naval Shipyard, San Francisco, California* Table 1. If the chemical~~

~~confirmation results exceeded hot spot goals, a step-out excavation was performed (extending vertical and horizontal limits).~~Work Plan Table 1 (CB&I, 2016). ~~This process was continued until the final limits of contamination were adequately bounded, both vertically and laterally, by samples below the project action limit. No soil exceeding the project action limits was left in place.~~ Figures 5 through 8 show the radiological screening and chemical sample locations, summarizing the analytical strategy for the freshwater and tidal wetlands, while Tables 5 through 7 summarize the progression of the chemical confirmation testing results. Where confirmation sample results exceeded the appropriate hot spot goals the excavation was stepped out and downward, as necessary, extending horizontal and/or vertical limits and then resampled. This process was continued until the final limits of contamination were adequately bounded, both vertically and laterally, by samples below the project action limit. No soil exceeding the project action limits was left in place.

As ~~presented in Field Work Variance (FWV)-05 (~~summarized in Tables 5 and 6~~)~~, chemical confirmation sample results exceeded the appropriate hot spot goals in sample grid locations (SU freshwater [FW]) FW-07, -08, -09, -25, -33, and -47 (Figure 5). Following the requirements of Work Plan Section 7.2.1.2 (CB&I, 2016), excavations were extended and additional confirmation samples were collected. This process was continued a second time in FW-08 and -47, and a third time in FW-25 due to some excavation sidewall samples exceeding the limit for lead. After failing the third such step-out, resulting in a step down approximately 3 feet bgs, this process was halted and Field Work Variance (FWV) 05 was drafted. As described within FWV-05, exploratory test pitting was conducted West of the failed sample results. The resulting data was used in an attempt to bound a revised area requiring over-excavation as proposed on Figure 2 of FWV-05. Based on the results of the completed exploratory test pitting, APTIM proposed the over-excavation of this area to an approximate depth of 4 to 7 feet bgs. The new excavation footprint was completed as presented in Figure 8 at a final depth approximately 5 feet bgs, which completely encompassed all five tests pits showing results exceeding the project clean-up limits. Exceeding the floor sample requirements of one bottom sample collected for every 2,500 square feet of excavation, a total of four floor samples were collected and verified to be below the cleanup criteria. Appendix AA presents the laboratory data quality assessment for the data summarized in Table 6. Once clean bounding samples had been established (Figure 8), the excavation area was backfilled to achieve final subgrade elevations with on-site graded soil that has been radiologically screened and cleared for use as fill within Parcel E-2. Appendix G presents data and maps regarding these excavations is presented along with FWV-05. Groundwater that was collected during the open excavation was pumped into the freshwater wetlands area for future management.

While grading within the vicinity of the freshwater wetland, APTIM removed approximately 1,204 cy of material suspected of containing methane-generating debris. This material was segregated into its own stockpile and tarped for air sampling. Following radiological and chemical clearance, this material was moved for placement within the assigned waste consolidation area, as described in Section 3.2.12.

Placement of wetland soil and vegetation will be implemented during the final phase of construction (Phase III), which will be awarded by the Navy under a separate task order.

3.2.11 Final Radiological Characterization Surface Survey

A final radiological characterization surface survey was performed throughout Parcel E-2 to identify and remove radiological contamination to a depth of 1 foot below the final elevation of the excavated subgrade surface in accordance with the DBR (ERRG, 2014). For survey design purposes, Parcel E-2 was divided into a total of 179 Class 1 surface SUs:

- 33 SUs in the east adjacent area
- 11 SUs in the shoreline area
- 18 SUs in the freshwater wetlands area
- 17 SUs in the panhandle area
- 36 SUs in the north perimeter area
- 57 SUs in the landfill area
- 7 SUs in the tidal wetlands area

Each SU had a maximum area of 1,000 square meters and Figure 5 shows the SU layout. Data analysis was performed and a separate decision was made for each SU as to its need for remediation and/or additional data collection.

Radiological characterization surveys included a gamma scan over 100 percent of accessible unsaturated areas, static measurements, systematic sampling, and biased sampling, if required, within each SU. The follow-up static measurements utilized either the RS-700 system or a 3-inch-by-3-inch sodium iodide (NaI) detector coupled to a Ludlum Model 2221 and global positioning system unit. Follow-up static measurements were collected at locations that were identified during review of the scan data as being over the scan investigation level (IL), or identified through the tiered Radiation Solutions Inc. (RSI) data analysis process as described in the Work Plan (CB&I, 2016). Static measurements exceeding the instrument-specific IL were subjected to additional characterization using a portable gamma spectroscopy unit. If the spectroscopic results of the follow-up measurement were inconclusive in designating the material as comparable to background or naturally-occurring radioactive material, a biased sample was collected for off-site laboratory for gamma spectroscopy analysis. Saturated areas of the SUs were subjected to systematic soil sampling only and did not receive a gamma scan due to the shielding properties of water. A minimum of 18 systematic soil samples were collected from each SU and were submitted to an off-site laboratory for gamma spectroscopy analysis. Ten percent of the samples (two per SU) were also analyzed for ^{90}Sr.

Locations of soil samples with radionuclide activity in excess of the release criteria were remediated by removing the soil within 1 foot in each direction around the location, designating the material as low-level radiological waste (LLRW), and collecting bounding samples post-remediation.

Only after receiving Radiological Affairs Support Office (RASO) approval of an SU, was restoration (e.g., backfill) of an area be allowed. Section 3.2.13 describes the construction of the foundation layer using on-site cleared material. The final covers will be constructed under a future (Phase III) Navy contract and are not included in this RACSR.

3.2.12 On-site Consolidation of Radiologically-Cleared Soil, Sediment, and Debris

Waste generated during RA construction and grading activities, including soil, sediment, and non-recyclable or non-reusable debris, provided it met the consolidation criteria (Table 3), was consolidated on site to establish the top of foundation layer elevation as shown in Design Drawing C13 (ERRG, 2014). Debris that was separated from soil (including concrete, bricks, timber, metal, rocks, etc) were radiologically screened in accordance with AMS-710-07-WI-40121, “Performing and Documenting Radiation and Contamination Survey” (APTIM, 20~~19~~20). Radiologically-cleared debris such as concrete, bricks, timber, metal, etc., were resized and reshaped as necessary, and buried at least 5 feet below the final protective layer to minimize the potential for damage to the final cover system. This depth was specified to result in a minimum cover thickness of 7 feet over consolidated debris, corresponding to 3 feet of cover fill over the debris, 2 feet of foundation layer soil, and 2 feet of cover soil over the liner. Based on the foundation grading plan, the northwest area of the landfill was selected for the waste (i.e., debris) consolidation area because it had the greatest capacity to receive waste while meeting the waste consolidation criteria established within the DBR (ERRG, 2014).

An estimated 9,754 cy of debris was generated during grading operations; this volume was greater than the calculated capacity of the waste consolidation area designated within the DBR (Design Drawing C13; ERRG, 2014). To accommodate this larger volume of debris, APTIM proposed an increased footprint to the waste consolidation area as presented in "Request for Information 005," issued May 1, 2018 (Appendix P). Following Navy approval on May 5, 2018, the final waste footprint shown on As-built Drawing C6 (Appendix C) was utilized for on-site waste consolidation while meeting remaining design criteria established within the DBR.

Generated debris was segregated from soil and staged on site until it could be processed for radiological clearance. As a means of pre-processing mixed material, a Warrior 1800 Powerscreen® was mobilized to the site in February 2018. Material processed through the Powerscreen®was segregated into soil and oversized debris. Segregated soil was transported to the RSY pads for radiological screening, as described in Section 3.3. Oversized material, once radiologically-cleared, was moved for placement within the assigned waste consolidation area. Material was arranged homogeneously in 1-foot lifts using an excavator with a "thumb" attachment to avoid clustering of similar materials and to minimize void space. Following the placement of each lift, void space within pieces of debris was filled with cleared soil to reduce the risk of future differential settlement. This process was continued until the top of the waste consolidation footprint was reached (i.e., 5 feet below the proposed foundation layer) or the oversized material had been consolidated.

Materials that did not meet the consolidation criteria, or were deemed unsuitable for waste consolidation (e.g., tires, fencing, or wood debris, which could not be chipped to reduce the risk of differential settlement resulting from wood decay) were characterized and disposed of in accordance with the waste management plan (Work Plan Appendix C; CB&I, 2016). Materials characterized as LLRW were stored on site until being disposed of by the HPNS LLRW Brokering Company. Appendix E includes the LLRW waste manifests. A total of three LLROs were identified and removed during waste consolidation survey activities. Appendix J includes the LLRO information. LLROs remain secured on site and controlled by the basewide contractor pending off-site waste shipment

3.2.13 Construction of Foundation Soil Layer

After RASO approval of the final radiological characterization surveys of the excavation soil from the RSY pads, radiological cleared soil was removed from the RSY pad for reuse in construction of the final foundation layer. The foundation soil layer was constructed in lifts to the elevations shown in in Design Drawing C13 (ERRG, 2014).

The foundation soil layer is 2 feet thick consisting of radiologically-cleared soil and is located directly beneath the protective liner. The final covers will be constructed under a future (Phase III) Navy contract and are not discussed in this RACSR.

Fill was placed using haul trucks and a dozer to spread cleared material in lifts of approximately 1 foot at a time until the appropriate slope and elevation was reached. The surface of each lift was compacted to a minimum density of 90 perfect of the maximum dry density ±3 percent optimum moisture based on modified Proctor density testing (ASTM 1557). Density testing of shallow soil by nuclear methods was conducted at a frequency of 1/10,000 square feet per lift. Sand cone testing (ASTM D1556) and moisture testing (ASTM D2216) were conducted at a frequency of 1/150,000 square feet per lift. Site soil that did not meet the compaction requirements was reworked and retested as necessary to achieve the required design specifications. During placement of soil fill, continuous observation by a designated member of the field engineering staff ensured that materials met the suitability requirements and that moisture content was controlled to ensure compaction specifications were met. Smith-Emery Geotechnical Services, a third-party American Association of State Highway and Transportation Officials-certified geotechnical testing firm, performed geotechnical laboratory testing and field confirmatory tests. Appendix M provides compaction testing results for the re-graded subgrade.

The foundation soil layer was graded to match the slope of the final cover, which will be constructed under a future (Phase III) contract. Radiologically-cleared material from the subgrade excavation was used to construct the foundation layer. By late October 2017, APTIM completed the radiological processing and backfill placement of excavated material, but remained short of the design foundation grade in several areas across the site. In an attempt to meet the Navy's needs for this contract task order, APTIM began deconstruction of the cleared RSY pads for reuse, consolidating the pad construction material into the foundation layer as well. APTIM also used available clean fill material that had previously been placed beneath RSY pads to balance and slope the area to accommodate their original construction. An estimated total of 8,600 cy of material were used from the RSY pads after deconstruction for incorporation into the final foundation grade; however, despite this effort, the final as-built topographic survey for the site (Appendix C) has indicated that the foundation design elevations have not been met in three areas: 1) A small section of shoreline between the landfill and the geogrid anchor; 2) The area surrounding the freshwater wetland; and 3) The panhandle area (where material had been previously borrowed to complete the DBR (ERRG, 2014) requirements for the soil anchor above the geogrid liner. The final foundation grading as-built topography is shown on As-built Drawing C6 (Appendix C). The areas where there is still a soil deficiency have been graphically represented on As-built Drawing C8.

To construct the foundation layer within the freshwater and tidal wetlands area, approximately 4,620 cy of clean fill from the "Bernard Pile" in Brisbane, CA was imported to the site as the soil bridge layer in accordance with DBR design drawing C19 (ERRG, 2014). Fill within the wetland areas was placed utilizing grade staking marked in the field to exactly 1 foot above the constructed subgrade surface shown on As-built Drawing C5 (Appendix C). The sampling and analysis plan (Work Plan Appendix B; CB&I, 2016) provides analytical requirements and procedures for clean fill import verifications. The approved import material transmittal package was presented to the Navy under Construction Submittal #011 (Appendix P).

3.2.14 Upland Slurry Wall Installation

The ROD (Navy, 2012) specifies that groundwater at Parcel E-2 will be controlled through the installation of two below-ground barriers; the nearshore slurry wall (installed by the Phase I contractor in 2016) and the upland slurry wall constructed under this RA. These subsurface hydraulic barriers, in conjunction with the French drain (Section 3.2.14.6) and upgradient well network (Section 3.2.15), were designed specifically to address the groundwater RAOs for the protection of wildlife specified in the ROD.

As designed, the upland slurry wall extends approximately 571 feet from the northern parcel boundary to the southern extent of the landfill waste in the western portion of Parcel E-2 (Design Drawing C5; ERRG, 2014). It is aligned perpendicular to the direction of groundwater flow in the western portion of the site to divert upgradient off-site groundwater away from groundwater that contacts landfill waste. DBR Specification Section 02 35 27 (ERRG, 2014) established the baseline specifications for the upland slurry wall with minor variations as discussed below.

The upland slurry wall was installed by the subcontractor Geo-Solutions, Inc. (GSI), who also installed the nearshore slurry wall in 2016. GSI's mix design, and the subsequent methods for installation and QC, were identical to those approved by the Navy for installation of the nearshore slurry wall which excluded the soil component as permitted by DBR Specification Section 02 35 27, paragraph 1.1.5.2 (ERRG, 2014). The upland slurry wall was constructed by installing a self-hardening cement-bentonite (CB) slurry wall, using a slurry trenching method of construction. The CB slurry was manufactured in GSI's on-site batch plant, and consisted of a blend of slag cement, Portland cement, and bentonite. Because the slurry is self-hardening, the additional step of replacing bentonite slurry used to hold open the trench with a soil-CB (SCB) backfill was avoided, expediting the installation procedure.

As designed, the upland slurry wall is considered a "hanging" slurry wall because it was not intended to key into an aquitard. The upland slurry wall was designed to be installed from the planned finish grade, down through a thin noncontiguous lens of Bay Mud, to an elevation of approximately -10 feet below msl. Some groundwater will flow under the upland slurry wall, but groundwater modeling predictions (DBR Appendix F; ERRG. 2014) indicate that upgradient flow will mostly be diverted around the upland slurry wall or diverted to the freshwater wetland via the French drain (Section 3.2.14.7) installed on the upgradient side of the upland slurry wall.

3.2.14.1 Compatibility Testing

The slurry mix design was the same CB slurry mixture tested and approved for use with the nearshore slurry wall construction (Gilbane Federal, 2017). The slurry mix design compatibility testing was completed in accordance with DBR Specification 02 35 27, "Soil-Cement-Bentonite (SCB) Slurry Trench," (ERRG, 2014) and submitted for approval in the "Final Mix Design Report" dated October 30, 2015. For reference, the "Upland Cement-Bentonite Wall Installation, Mix Design Report" was presented for Navy approval in Construction Submittal #007 (Appendix P).

3.2.14.2 Slurry Mixing Plant

The slurry mixing plant was separated into two operations: 1) bentonite slurry preparation and 2) CB slurry preparation. The bentonite plant contained the necessary equipment for preparing the bentonite slurry including low-profile, high-shear mixers capable of producing a stable suspension of bentonite in water, hydration tanks and circulating pumps. Hydrated bentonite slurry was conveyed to the CB slurry mixing plant. This plant primarily consisted of a series of high-speed/high-shear colloidal mixers with a static agitator where slag and cement were added to the bentonite slurry to produce the final CB slurry. The batch plant was assembled by GSI near the excavation area, covering an area approximately 150 feet by 150 feet. The prepared slurry was pumped to the point of use at the trenches via fusion-welded high-density polyethylene pipe.

3.2.14.3 Materials

Water used for the slurry was drawn from a hydrant on the property. Approximately 250,000 gallons of water were used over the course of the project. The bentonite used for the slurry was premium-grade sodium montmorillonite and met the requirements of American Petroleum Institute (API) Specification 13A Section 9 for sodium bentonite for oil well drilling fluid materials. Compatibility of the bentonite with site conditions was verified through laboratory testing prior to construction. Bentonite was delivered from the supplier in 3,000- to 4,000-pound super sacks, along with the manufacturer's certification and bill of lading for each truckload. The slag cement conformed to ASTM C989 and was Grade 100 or 120, ground granulated blast furnace slag. The slag was delivered in bulk along with the manufacturer's certification and bill of lading for each truckload and was stored on site in a pneumatic tank and silo. The Portland cement conformed to ASTM C150. The Portland cement was packaged in 47- or 94-pound bags and was stored on pallets.

3.2.14.4 Cement-Bentonite Slurry Preparation

The mix design for the CB slurry was 4.5 percent Western Clay bentonite, 12 percent slag cement, 0.5 percent Portland cement, and 0.1 percent soda ash by weight of water. The CB slurry was prepared in a custom-built, continuous-cycle automated batch plant.

The bentonite slurry was prepared by mixing water and bentonite using a jet-shear mixer. The super sacks of bentonite were mounted over the material hopper, and the bentonite powder was drawn into the jet mixer via the Venturi effect. The bentonite slurry was ejected directly into a temporary storage tank where it was re-circulated until being transferred to the CB mix tank.

The CB slurry was prepared by blending the bentonite slurry with cement in a high-speed colloidal mixer and was delivered into a secondary mixing tank using a variable-speed pump. The slag was added from the silo via a screw-feed auger that was completely enclosed in the auger housing. Portland cement was added by hand through the grate at the top of the mixer. A recirculation pump with a mass-density flow meter attached to the mixing tank provided a direct read of the density of the CB mix. Periodic mud balance tests were performed as a check on the meter, in accordance with API Recommended Practice 13B-1 (API, 1997). Test results were provided in the daily reports (Appendix K). The mixed CB was pumped to the trench using a positive-cavity Moyno pump through a 6-inch HDPE pipeline. The level of the liquid in the mixing tank was monitored by sensors, and the operator maintained the water level to the maximum functional capacity.

3.2.14.5 Excavation and Installation

A working platform was constructed to meet the final grade prior to trenching and installation of the upland slurry wall. The platform required soil fill along the alignment of the upland slurry wall and was constructed to the lines and grades presented in As-built Drawing C7 (Appendix C).

The upland slurry wall was designed to be excavated from a platform approximately 8 feet above msl to a depth of approximately 10 feet below msl using an excavator capable of excavating approximately 30 feet bgs using the slurry trenching method. The excavator was fitted with a 24-inch-wide bucket to ensure a minimum 24-inch-wide continuous trench. The trench was excavated in a series of approximately 20- to 40-foot-long cuts. The prepared slurry was introduced to the trench as the trench was excavated, to maintain sidewall stability and to minimize the intrusion of groundwater. Spoils and excess slurry from the trench removed from the excavation process were direct-loaded into dump trucks for transport to the RSY pads for radiological processing. Saturated soil was first placed in drying cells to dry prior to transport to RSY pads. The unsaturated excavated surfaces were radiologically surveyed to the extent practicable.

The working platform was surveyed to provide elevation points and the depth of the trench was measured at least every 10 lineal feet. The trench alignment and offset control points were also surveyed prior to construction activities. Survey markers with station locations were placed at 10-foot intervals along the upland slurry wall centerline. Depth measurements for each day of excavation were presented in the daily reports (Appendix K).

On October 30, 2017, GSI began mobilization activities for construction of the upland slurry wall. GSI's mobilization and site setup activities were completed on November 10, 2017. On November 13, 2017, excavation and slurry installation activities began. Excavation of the upland slurry wall proceeded as planned for approximately the first 100 linear feet of construction, after which GSI reported refusal at approximately 15 feet bgs (-1.5 feet below msl). The unknown obstruction was noted as something hard, fairly smooth and continuous, indicating the presence of a feature different than the rubble and debris encountered at the higher elevations. On November 20, 2017, digging was resumed along the original alignment at a location identified to be just beyond the noted obstruction. Digging continued without further incident and on November 22, 2017, the excavation of the remaining length of upland slurry wall construction was completed.

On November 20, 2017, there was a conference call with the Navy RPM and Navy Design Engineer (ERRG) to discuss the upland slurry wall status and what needed to be done to meet the design objectives. At the conclusion of the call the Navy representatives believed that additional investigation is necessary prior to pursuing deviation to the design with the regulatory agencies. In summary, the upland slurry wall was constructed along the designed alignment and to the prescribed depth, with the exception of a 200-foot section that came in to contact with refusal about mid-depth as shown on As-built Drawing C7 (Appendix C). Section 4.2 presents a discussion of the post-construction supplemental investigation.

After the top of the upland slurry wall hardened sufficiently, a temporary anti-dessication cap was placed on the top of the upland slurry wall. A 1-foot-thick layer of uncompacted soil was placed over the upland slurry wall by scraping material off the adjacent work platform. The final trench cover was installed after the entire alignment of the trench and temporary cover was installed. The final trench cover was installed by excavating a 2-foot-deep, 6-foot-wide trench from the surface. A small amount of soil was bermed on the outside of the excavation for the placement of backfill above the level of the work platform. The excavation was filled with CB material, which formed the final trench cover after curing.

Approximately 760 bank cy of soil and debris were excavated during the upland slurry wall construction. The excavated material was radiologically screened, as described in Section 3.1.2. The final dimensions of the upland slurry wall, as constructed, are presented on the final Upland Slurry Wall and French Drain As-built Drawing C7 (Appendix C).

Appendix I includes photographic documentation of these activities.

3.2.14.6 French Drain Installation

The French drain was constructed to divert groundwater and surface water runoff to the freshwater wetland. The French drain was installed along the upgradient (western) side of the upland slurry wall, with a minimum distance of 5 feet from the upland slurry wall, in accordance with the DBR (ERRG, 2014). The French drain consisted of a buried 4-inch perforated schedule 80 polyvinyl chloride pipe embedded within the trench filled with gravel and geofabric. Pipe cleanouts were installed every 200 feet along the alignment of the pipe to facilitate future maintenance. The drain pipe and gravel backfill around the pipe were wrapped in geotextile to filter out sediment from incoming water and to minimize potential drain clogging. The French drain was constructed as designed to an elevation of 6 feet msl at a 0 percent slope (ERRG, 2014). The final dimensions of the French drain, as constructed, are presented on the final Upland Slurry Wall and French Drain As-built Drawing C7 (Appendix C).

Appendix I includes photographic documentation of these activities.

3.2.14.7 French Drain Outlet (Inlet Structure to Freshwater Wetland)

The buried 4-inch drain line was installed to the location shown on As-built Drawing C7, where it has been temporarily capped pending installing a concrete aeration apron at the discharge point into the freshwater wetlands (ERRG, 2014). The flow from the French drain pipe will be monitored and managed under a future RA contract to ensure that the chemical concentrations for water entering the freshwater wetlands does not exceed surface water quality criteria. A sampling port and isolation valve will be installed in accordance with the DBR (ERRG, 2014) to allow for regular monitoring of the water, and to prevent water discharge into the wetlands if the water quality criteria are exceeded.

3.2.15 Installation of Monitoring and Extraction Wells and Piezometers

After the installation of the shoreline revetment, 4 piezometers, 3 monitoring wells, and 13 leachate monitoring/extraction wells were installed, predominantly in accordance with the DBR (ERRG, 2014). The final locations for wells and piezometers are shown on As-built Drawing C2 (Appendix C). The wells and piezometers were installed using a Geoprobe® 7720 drill rig equipped with direct-push and hollow-stem auger capabilities. Prior to auger-drilling, direct-push continuous soil cores were collected in acetate sleeves in order to log the lithology and identify the top of the Bay Mud layer. In between each auger-drill or direct-push, auger and bore equipment surfaces were radiologically surveyed to verify the absence of embedded LLRO's and surface contaminations. To assist in this process, the equipment was dry brushed to remove visible soils as necessary. After verifying the absence of radiological contamination, the equipment was then decontaminated with a steam cleaner prior to advancing to the next location. Borehole logging was conducted by a geologist under supervision of a State of California Professional Geologist. Soil was classified using the Unified Soil Classification System (ASTM D2488), and was evaluated for grain size, soil type, and moisture content. The removed, over-burden soil was transported to the RSY pads for radiological screening, as described in Section 3.3.

The depth of the screen interval for the piezometers ranged from 13 to 18 feet bgs, based on specific conditions observed in the field by the geologist. The screen length (0.020-inch slot size) was either 5 or 10 feet, depending on conditions observed in the soil cores, and targeted the A-aquifer located above the Bay Mud layer. The filter pack used for the piezometers was Monterey #3 sand and extended to approximately 3 feet above the screen interval.

Three monitoring wells were installed adjacent to the shoreline revetment as shown on As-built Drawing C2 (Appendix C). The monitoring wells were constructed with 4-inch schedule 40 polyvinyl chloride. The depth of the screen interval (0.010-inch screen slot size) for the monitoring wells ranged from 18 to 19 feet bgs; based on specific conditions observed in the field by the geologist. Each screen was 10 feet in length and targeted the A-aquifer located above the Bay Mud layer. The filter pack used for the monitoring wells was Monterey #2/12 and extended to approximately 3 feet above the top of the screen. Each well was surged prior to placing the transition seal to promote settling of the sand pack. For the three monitoring wells, ~~two~~2 feet of bentonite chips were placed on top of the sand pack and were hydrated before placement of the grout; the piezometers and leachate extractions wells used a transition seal of #60 sand. The annular space of the wells was grouted from the top of the bentonite seal to the ground surface, after which the grout would settle to approximately 3 feet bgs. As well completions are to be finalized by the Navy's follow-on contractor, the wells were generally left with 2 plus feet of casing sticking up above ground surface and a compression cap covering the opening. A cone or similar demarcation item was additionally left at each well location to increase visibility so as to avoid contact with any potential vehicle traffic at the site.

Thirteen 6-inch leachate monitoring/extraction wells were installed in accordance with the DBR (ERRG, 2014) approximately every 100 feet along the nearshore slurry wall alignment as shown on Figure 9. All extraction wells, with the exception of EX Well-013 were installed on the landfill side of the nearshore slurry wall. EX Well-013 encountered refusal on two occasions and was installed at the very end of the slurry wall alignment. The wells were constructed with schedule 80 polyvinyl chloride in conformance with the DBR. The wells extended to the depth of Bay Mud, as identified through continuous soil coring. The depth of the screen interval (0.020-inch screen slot size) ranged from 12 to 21 feet bgs; based on specific conditions observed in the field by the geologist. The filter pack used for the leachate monitoring/extraction wells was Monterey #3 sand and extended to approximately 3 feet above the screen interval. In accordance with the technical specifications of the DBR (ERRG, 2014), each of the three new monitoring wells were developed within 72 hours of their installation. (Appendix X includes data for the development water characterization.) Well sampling of the completed upgradient well network will be the responsibility of a future Navy contractor.

Soil borings and spoils from the installation of the wells were transported to the RSY pads for radiological screening. In accordance with the DBR (ERRG, 2014) the three monitoring wells were developed, and the development water was placed in 55-gallon drums. A total of ten 55-gallon drums of water were generated. Appendix X includes data for the development water characterization. Pending RASO concurrence, this water will be reused on site for soil conditioning.

Each feature within the monitoring well network (As-built Drawing C2; Appendix C) was installed in accordance with the DBR design drawings and specifications (ERRG, 2014) and was extended to the approximate elevation of the final cover grade. However, Technical Specification 33 24 13, Section 2.8, and Design Drawings C6, C7, and C27 (ERRG, 2014) call for each well to be completed with a steel lockable protective casing (well box) set in a concrete pad constructed around each well casing at the final ground level elevation. To properly anchor the previously installed geogrid, the Navy required fill material to be placed over the entire upland footprint of geogrid to the finished grade of the final cover. Per the DBR, it is understood that this material is only intended to be temporary and will be removed during Phase III of the RA to allow for installation of the final protective liners; therefore, with Navy concurrence to Field Change Request (FCR)-006, installation of the final surface well completions will be deferred to the next phase contractor.

Appendix F presents boring logs and data related to the monitoring well network installation. Appendix I includes photographic documentation of these activities.

3.3 Radiological Screening of Excavated Soil

The following subsections describe the radiological screening process of the excavated soil.

3.3.1 Radiological Surveying and Release Criteria

Several types of radiological surveys were used during the RAs, depending on the material and type of radiation being measured. Each detector had its own IL, that is, the level of radioactivity used to indicate when additional investigation may be necessary. The following subsections describe the relevant ILs or investigation methods for the RA.

3.3.1.1 3-inch-by-3-inch NaI Detector

The 3-inch-by-3-inch NaI detector was used for gamma scanning surveys of various SUs and for static measurements. Gamma scanning and static measurements collected from the reference area were used to develop instrument-specific scan and static ILs. Each IL was based on the instrument-specific mean background value plus 3 standard deviations of the mean (CB&I, 2016). Measurement locations that exceeded the instrument-specific scan IL during gamma walkover surveys were selected for follow-up static measurements, and static measurements that exceeded the instrument-specific static IL during follow-up investigations were subjected to additional characterization or biased sampling.

3.3.1.2 256-cubic-inch NaI Detector

The RSI detector system uses two large 256-cubic-inch NaI detectors and is capable of obtaining and presenting the gamma energy spectra of collected data. Gamma walkover data collected with the RSI detector system was analyzed using the tiered approach, as described in Work Plan Section 5.5.3.2 (CB&I, 2016). Locations selected for follow-ups were subjected to a one-minute static measurement with the RSI detector. Static measurements that were determined to be above background were subjected to biased sampling.

3.3.2 Radiological Screening Process for Radiological Screening Yard Pads

Excavated soil was spread onto RSY pads, each measuring approximately 104 feet by 104 feet, to an even thickness of approximately 9 inches for scanning with the RS-700 system. Thirty-seven pre-existing RSY pads were reused in order to scan the excavated material. A minimum of 18 systematic samples were collected from each RSY pad, with 10 percent of the samples also being analyzed for ^{90}Sr (two samples per RSY pad).

A gamma scanning survey of 100 percent of the accessible area was conducted with the RS-700 system for each pad. The scans were performed with the RS-700 system mounted to a motorized cart at a speed of 0.25 meters per second, with the detector maintained at a height of 15.24 centimeters above the ground, with each pass offset approximately 112 centimeters from the previous pass. The gamma scan data was reviewed using the analysis software RadAssist, where virtual detector (VD) 1 refers to both detectors summed, VD3 refers to the left detector, and VD4 refers to the right detector. Ten regions of interest (ROIs) were established for radium, radium progeny, and other naturally-occurring or anthropogenic gamma-emitting radionuclides that may be of interest (CB&I, 2016).

The data was first reviewed in RadAssist for elevated count rates. Next, the count rates for several ROIs were plotted and reviewed for peaks in the count rate. The Z-scores were calculated for each location in ROIs for VD1, VD3, and VD4. Local Z-scores using a moving average, and semi-local Z-scores using the global average but a moving average for the standard deviation, were also calculated to identify smaller areas of elevated counts or to identify elevated counts in areas with variable background (CB&I, 2016). These parameters were used to identify locations for follow-up investigations.

Follow-up investigations consisted of reacquiring the location of the elevated count rate and obtaining a one-minute static gamma count with the RS-700. The resulting spectrum was compared against the critical levels of the ROIs of interest based on the reference area spectrum to determine if activity was present above background. If a static measurement exceeded one or more critical levels for the ROIs of interest, a biased sample was collected at that location (CB&I, 2016).

Locations with elevated gamma count rates that were not attributable to naturally-occurring radioactivity were overexcavated to a minimum of 1 foot in each direction of the surrounding soil. The removed material was designated as LLRW, and if an LLRO was present, it was removed, characterized, and securely stored. A total of 21 LLROs were identified during screening of the RSY pads. Appendix J contains LLRO information.

3.3.3 Release Criteria

Table 2 presents the remediation goals for radionuclides in soil and sediment, and the waste-consolidation-comparison criteria.

3.4 Waste Characterization and Management

The Parcel E-2 remedial activities generated several waste streams. These waste streams included soil and debris, low-level radioactive waste, liquid wastes, and metal debris.

3.4.1 Soil and Debris

Approximately 112,873 cy of soil were generated for reuse during the remedial activities. The soil was sampled for ROCs and COCs, as outlined in Tables 1 and 2. Soil that was radiologically and chemically cleared was used as fill material within Parcel E-2.

Approximately 9,754 cy of large debris were recovered during the excavation activities. These materials were radiologically-cleared prior to disposal within the assigned waste consolidation area (Section 3.2.12). Appendix S includes survey documentation.

A detailed summary of all material transported off-site for disposal is presented in Appendix X, which in summary includes approximately 2,310 tons of Resource

Conservation and Recovery Act hazardous material; approximately 62.43 tons of non-hazardous construction debris; 774 cy of non-hazardous soil; and 98,380 pounds of recycled steel sheet pile.

3.4.2 Low-Level Radioactive Waste

Materials that exceeded the radiological release criteria in Table 2 were handled as LLRW. Materials that were determined to be ~~NORM~~naturally occurring radioactive materials, such as ~~fire-brick~~firebrick, were removed during the ex-situ soil screening process and also dispositioned as LLRW. Approximately 85 cy of soil and other materials were placed in bins as LLRW. The bins were transferred to the Navy LLRW contractor for disposal. Appendix E includes LLRW waste manifests.

3.4.3 Liquid Wastes

Approximately 20,000 gallons of liquid waste generated by pumping from the excavations supporting the cutting of the shoreline steel sheet-pile wall was contained in a frac tank. The water primarily consisted of rainwater and groundwater. Samples were collected and analyzed for project ROCs and were found to be satisfactory for reuse. Appendix X includes TestAmerica sampling results. With RASO concurrence, the water was reused on site for soil conditioning.

3.4.4 Metal Debris

Approximately 310 linear feet of steel sheet-pile wall was cut to an elevation below the design foundation grade and removed during the remedial activities. The steel sheet-pile wall sections were radiologically surveyed for release. The steel sheet-pile wall sections were designated as non-LLRW and were sent off site for recycling. Appendix N includes survey results.

During clearing and grubbing of the site, additional metal debris such as chain link fencing, railroad rails, and other assorted metal fragments were recovered. The debris was radiologically surveyed and cleared as non-LLRW prior to being sent off site for recycling.

A measured total of 150 tons of metal debris was shipped off site to Sims Metal Management in Richmond, California for recycling.

3.5 Biological Survey

Pursuant to the ROD (Navy, 2012) and as specified in the DBR (ERRG, 2014), a focused biological survey was performed in the areas to be affected by the remediation activities described in the Work Plan (CB&I, 2016), prior to implementation of the remedy. Biological surveys, sweeps, and compliance monitoring were performed by NOREAS Inc. on an as needed basis, during project activities from early August 2016 through late June 2018. The objective of this field work was to identify potential bird species and active nests that are protected under the Migratory Bird Treaty Act and the California Fish and Game Code within the study area, while recommending reasonable measures to safeguard the adequate protection of special status species and regulated biological resources in the unlikely event that they occur within the study area. Appendix T includes the results of biological surveys and daily biological inspections.

3.6 Air Monitoring

Prior to the start of earthmoving activities, air monitoring stations were set up both upwind and downwind of the construction activities. Air monitoring was performed in accordance with the dust control plan (Work Plan Appendix D; CB&I, 2016). The air was monitored and sampled for PM10 (particulate matter less than 10 microns in diameter), total suspended particulates, arsenic, lead, manganese, asbestos, PCBs, polycyclic aromatic hydrocarbons, and ROCs during earthmoving activities. Radiological air monitoring was conducted upwind and downwind of the excavations and in the immediate vicinity of each excavation site. Construction activities did not result in an exceedance of the established threshold limit values during the project. Appendix U includes air monitoring results.

Due to rain, air monitoring was not conducted on the following dates:

- December 8 through 23, 2016
- January 3 and 4, 2017
- April 12 and 13, 2017
- April 17 and 18, 2017
- November 3, 2017
- November 9 and 10, 2017
- December 4, 2017
- December 15 through 17, 2017

- December 27 through 29, 2017
- January 4 through 26, 2018
- February 26 through March 27, 2018
- April 6 through 17, 2018
- October 2, 2018

3.7 Material Potentially Presenting an Explosives Hazard

On September 18, 2017, an expended 40-millimeter shell casing was discovered in panhandle SU 11. The item was inspected and was found to be free of munitions and explosives of concern and material potentially presenting an explosives hazard. The item was also surveyed for radioactivity and was found to be releasable. The item was disposed and destroyed accordingly. Appendix D includes documentation for the item.

3.8 Final Topographic Survey

After construction activities were completed, activities were surveyed by Bellecci & Associates, under supervision of a California-licensed land surveyor, to document the final locations and elevations. Appendix H includes results of the final topographic survey and Appendix C presents the as-built drawings.

3.9 Decontamination and Release of Equipment and Tools

Equipment and personnel that exited work areas were decontaminated in designated decontamination areas located near the work boundary exits. Visible dirt was first removed from equipment using a masselin wipe. Equipment was then frisked to confirm the absence of radioactivity above control levels in Table 1 of *Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors* (Atomic Energy Commission, 1974). Larger equipment, such as mini-excavators, were dry brushed over an impermeable surface for decontamination.

3.10 Deconstruction of Radiological Screening Yard Pads

After radiological screening of materials was completed, and Navy concurrence with characterization data, the excavated materials were removed from the RSY pads, and 28 of the 37 RSY pads were subsequently radiologically screened for release. RSY pads C1 through C3 and the E RSY pads were left in place for future use by other Navy projects. The radiological screening included a 100 percent gamma walkover survey, static follow-up measurements, systematic sampling, and biased sampling if required. The area was downposted from a radiologically-controlled area for the deconstruction of the 28 RSY pads. RSY pad material that met the consolidation criteria was incorporated into the Parcel E-2. Foundation layer after deconstruction of the pads, the area was lightly graded to match existing topography, and was restored in accordance with the requirements for Parcel E-2.

Appendix Z contains the survey data reports for the deconstruction of the 28 RSY pads.

3.11 Demobilization

For demobilization, construction equipment and materials were surveyed, decontaminated, and removed, and contaminated materials were collected and disposed. Site cleaning was performed, which included repair of erosion or runoff related damage, removal of materials such as excess construction material, wood, and debris, and the removal of construction equipment and storage boxes. Demobilization also included inspection of the site, and the issuance of a certification statement (Section 8.0).

3.12 Deviations from Planning Documents

A total of six FCRs and FWVs were created and implemented during this project. FCRs and FWVs were prepared and approved to address unexpected changes or to improve production. The FCRs and FWVs include the following:

- FCR-001 (Regulatory Agencies Reviewed): Revises Worksheet 15.1 of the sampling and analysis plan (Work Plan Appendix B; CB&I, 2016) to show laboratory reporting limits for the ROCs as Decision Level Concentration and not Minimum Detectable Concentration.
- FCR-002 (Regulatory Agencies Reviewed): Adds a paragraph to the "Screening of Excavated Soils" section of the Work Plan (CB&I, 2016) to allow for the stacking of layers on RSY pads.
- FCR-003 (Regulatory Agencies Reviewed): Adds text to the "Survey Instrumentation" section of the Work Plan to include the use of the ORTEC Trans-Spec-DX-100 portable gamma spectroscopy unit, to improve the ability to characterize anomalies as naturally-occurring radioactive material or a potential LLRO.
- FWV-04: Modifies the "Site Grading to Construct Final Subgrade" section of the Work Plan to clarify that a 12-inch layer of the interim landfill cover would be

radiologically screened in place prior to excavation and grading and would be excavated in a 12-inch lift after radiological screening and sampling.

- FWV-05: Modifies the sampling and analysis plan (Work Plan Appendix B) and the “Excavation to Construct Future Wetlands” section of the Work Plan. Due to sample results exceeding the hot spot goals for lead, the excavations were extended. It also proposed the use of an alternate DoD-accredited laboratory to analyze the samples with a shorter turnaround time, due to its proximity.
- FCR-006 (Regulatory Agencies Reviewed): Seeks Navy concurrence to remove the requirement for APTIM to install the final surface well completions during this phase of construction. The Phase III contractor will inherit the responsibility for installing the final surface vault/concrete pad following the installation of the final liner system and overlying protective soil cover.

4.0 [AUTOTEXTLIST \s "Break" \t "Right-click to change break type" * MERGEFORMAT]Demonstration of Completion

The ROD (Navy, 2012) specified the RAOs that were developed to protect human and ecological exposure to COCs and ROCs in solid waste or soil. Through construction of the shoreline revetment; construction of the upland slurry wall; excavation for freshwater and tidal wetlands; site grading and consolidation of excavated soil, sediment, and debris; and radiological surface scanning, remediation, and clearance, these RAOs have been ~~achieved. The following subsections describe the demonstration of completion of the~~in part achieved. Further evaluation of the long-term performance of the upland slurry wall and freshwater wetlands will be conducted in accordance with the “Remedial Action Monitoring Plan” (RAMP) for Parcel E-2 (ERRG, 2014), and in the Five-Year Review. In addition, the Navy shall prepare a post-remedial action study work plan to evaluate whether the Phase II remedy is operational and functional. This forthcoming work plan will describe the specific tasks needed to conduct ongoing routine performance monitoring, as necessary, to evaluate the performance of the remedy as installed until the full scope of the DBR (ERRG, 2014) has been implemented. Once all phases of the Parcel E-2 RA are completed and requirements of the ROD are met, the documentation that the RAOs have been achieved will be presented in the final remedial action completion report for the site. The following subsections describe the demonstration of completion of the Phase II RAs for Parcel E-2.

4.1 Shoreline Revetment

The final revetment structure was installed to the lines and grades established in the DBR (ERRG, 2014) with a crest elevation 9 feet above msl as documented through field survey and shown on As-built Drawing C3 (Appendix C). Approximately 2,755 tons of filter stone and 5,625 tons of armor stone was used to complete installation of the shoreline revetment at Parcel E-2. The approved riprap product data sheets and test reports were presented to the Navy in Construction Submittal #015.

To achieve the minimum factors of safety for geotechnical practice, approximately 141,600 square feet of geogrid liner (Tencate Miragrid® 22XT) was installed as continuous strips of material running perpendicular to the revetment slope. Each strip of geogrid was installed in accordance with the design specifications as provided in the DBR (Appendix C, Section 31 05 21; ERRG, 2014). The approved geogrid product data sheets and test reports were presented to the Navy in Construction Submittal #014. To address the potential geogrid anchoring deficiency, APTIM re-excavated approximately 3,500 cy of previously cleared and placed soil from the panhandle area, placing the reallocated soil over the geogrid to the final grade contours.

A 3-foot-tall concrete seawall was constructed at the crest of the revetment to increase the wave runup protection to a final design elevation of 12 feet above msl as verified through field survey. The concrete seawall was reinforced using steel rebar in compliance with Technical Specification 03 30 00, "Cast-in-place Concrete" and Transmittal #003 (Appendix P) and was formed using concrete with a minimum design strength of 5,000 psi. Concrete test cylinders were collected in accordance with ASTM C31 at the frequency listed in the project specifications (ERRG, 2014). Performance testing in accordance with ASTM C39 was used to verify that the strength met the design strength. A Total of 57 cylinders were tested after a 28-day curing period, demonstrating an average strength of 6,948 psi with a low of 5,590 psi. Appendix M presents verification of the design concrete strength.

4.2 Upland Slurry Wall and French Drain

The upland slurry wall was installed by the same subcontractor who installed the nearshore slurry wall in 2016. The mix design, and the subsequent methods for installation and QC, were identical to those approved by the Navy for installation of the nearshore slurry wall, which excluded the soil component as permitted by DBR Specification Section 02 35 27, paragraph 1.1.5.2 (ERRG, 2014). The slurry mix design compatibility testing was completed in accordance with DBR Specification 02 35 27, "Soil-Cement-Bentonite (SCB) Slurry Trench," and submitted for approval in the "Final

Mix Design Report" dated October 30, 2015. The upland slurry wall was constructed along the designed alignment and to the prescribed depth, with the exception of a 200-foot section that came in to contact with refusal about mid-depth, as shown on As-built Drawing C7 (Appendix C). Appendix K presents the upland slurry wall field reports and testing results.

Following the recommendation of the Navy's design engineer to investigate this obstruction, a direct-push drill rig was mobilized to the site on September 18, 2018. At total of 12 step-out locations were investigated using a 3.5-inch-diameter drive casing in an attempt to confirm the presence/absence of a buried obstruction in relation to the proposed upland slurry wall alignment (As-built Drawing C7; Appendix C). Essentially no drill cuttings were generated by the direct-push rig, nor were geotechnical samples collected. The 12 selected locations encountered difficult driving conditions at or very near the same subsurface elevation, with 6 locations meeting complete refusal of the drill rig. These 6 locations were able to reach the design depth only after significant effort with no discernable limit of subsurface obstruction.

Further review of boring logs from historic documentation within the area (*San Francisco Naval Shipyard, San Francisco California, Advance Planning Report for Land Excavation and Fill, Public Works Program FY 1958* [Navy, 1958]) appear to indicate a distinct layer of serpentine weathered rock encountered approximately 10 feet bgs in the northwestern corner of the Parcel E-2 site. The information collected in the field, coupled with a historical records search would appear to indicate that obstruction encountered was geologic in nature rather than man-made. In addition, the obstruction appears to form its own barrier in this section of the slurry wall alignment. As such, even though the hanging slurry wall installation was not completed exactly as designed, the Navy anticipates it will function equally as well due to the geologic obstruction diverting water away from the landfill. ~~Therefore, the Navy recommends leaving the slurry wall as currently constructed with no further alterations to the target depth.~~

Further evaluation of the long-term performance of the upland slurry wall and freshwater wetlands will ~~now~~ be conducted in accordance with the ~~Remedial Action Monitoring Plan (~~RAMP~~)~~ for Parcel E-2 (ERRG, 2014), and in the Five-Year Review. ~~The data collected in accordance with~~No further action is required for this RA component; however, the ~~RAMP will be used~~Navy plans to ~~verify that the~~ prepare a post-remedial action study work plan to evaluate whether the Phase II remedy~~, as installed, meets the RAOs in the ROD~~, is operational and functional. This forthcoming work plan will describe the specific tasks needed to conduct ongoing routine performance monitoring ~~will be documented in a future deliverable separate from this RACR~~, as necessary, to evaluate the performance of the remedy as installed until the full scope of the DBR

(ERRG, 2014) has been implemented. Once all phases of the Parcel E-2 RA are completed and requirements of the ROD (Navy, 2012) are met the documentation that the RAOs have been achieved will be presented in the final remedial action completion report for the site.

4.3 Site Grading and On-site Consolidation

Site grading was performed across much Parcel E-2, including the landfill, the site perimeter, the upland panhandle area, and the east adjacent area to establish the subgrade for the designed protective covers as shown on Design Drawing C12 (ERRG, 2014). Excavations were completed by SU in 12-inch lifts. Following each lift, an RCT performed a radiological surface survey of in situ unsaturated soil to identify and allow removal of potential contamination and/or LLROs as soil was excavated as described. This process of surface screening before each 12-inch lift was repeated in unsaturated soil until the target subgrade elevation was achieved. Based on the final survey, a total measured volume of 112,873 cy of waste and soil was generated for reuse on the site. A graphical representation of the final subgrade cut volumes, by area, is shown on As-built Drawing C5 (Appendix C).

4.4 Final Radiological Characterization Surface Survey

The 179 SUs were radiologically surveyed after the excavations were complete. During these surveys, a total of 18 LLROs were identified and removed. Appendix J presents LLRO information. Appendix V provides data reports for the surveys of these SUs. Data demonstrates compliance with project remediation goals.

4.5 Construction of Foundation Soil Layer

After RASO approval of the final radiological characterization surveys of the excavation soil from the RSY pads, radiological cleared soil was removed from the RSY pad for reuse in construction of the final foundation layer. Radiologically-cleared debris such as concrete, bricks, timber, metal, etc., were resized and reshaped as necessary, and buried at least 5 feet below the final protective layer to minimize the potential for damage to the final cover system. The final waste footprint shown on As-built Drawing C6 (Appendix C) was utilized for on-site waste consolidation while meeting remaining design criteria established within the DBR (ERRG, 2014).

Following final site grading, APTIM collected data from the completed as-built topographic survey finalized on June 10, 2019 by Bellecci & Associates (Appendix H). An engineering review of the final as-built topographic survey indicates the east adjacent, North Perimeter, and landfill areas of the site have been constructed to grade. The areas where there is still a soil deficiency have been graphically represented on As-built Drawing C8 (Appendix C). Based on the final as-built survey for the site, a delta of 9,277 cy of fill was calculated as still required to achieve the design foundation grade presented within the DBR (ERRG, 2014).

Pre-final and final site inspections were held on site on June 11, 2019 and August 15, 2019 respectively. During the pre-final inspection, a punch list of additional work items was developed, including several items related to the condition of the final foundation soil layer. The purpose of the final 'acceptance' inspection was to verify that items identified as incomplete or unacceptable during the pre-final inspections were completed and acceptable. The final acceptance inspection included verification that punch-list items identified during the pre-final inspection were completed as discussed. These punch-list items, including deferral to import, place, and compact the estimated 9,277 cy of fill required to complete construction of the foundation layer, were verified as complete and acceptable by the Navy RPM on August 15, 2019.

Appendix B presents discussion and resolution of the pre-final and final site inspection checklist.

4.6 Installation of Monitoring and Extraction Wells and Piezometers

Each feature within the monitoring well network was installed in accordance with the DBR design drawings and specifications (ERRG, 2014) and was extended to the approximate elevation of the final cover grade. However, Technical Specification 33 24 13, Section 2.8 and design drawings C6, C7, and C27 call for each well to be completed with a steel lockable protective casing (Well Box) set in a concrete pad constructed around each well casing at the final ground level elevation. To properly anchor the previously installed geogrid, the Navy required fill material to be placed over the entire upland footprint of geogrid to the finished grade of the final cover. Per the DBR, it is understood that this material is only intended to be temporary and will be removed during the Phase III RA to allow for installation of the final protective liners; therefore, with Navy concurrence to FCR #006, installation of the final surface well completions will be deferred to the next phase contractor.

Appendix F presents boring logs and data related to the monitoring well network installation. Appendix I includes photographic documentation of these activities.

4.7 Radiological Screening of Excavated Soil

Excavated soil was placed on the RSY pads and radiologically screened, as described in Section 3.3. The soil was spread onto the 37 RSY pads in 337 lifts or “uses~~. 22~~.” Twenty-two of the 42 LLROs were identified and removed during screening of the soil on the RSY pads. Appendix J includes the LLRO information. Appendix Z provides data reports for the surveys of each RSY. All final, non-remediated sample results demonstrate compliance with the radiological RAO and project remediation goals, and no further action is required.

4.8 Risk Modeling

Risk modeling was performed using the maximum non-remediated radiological concentration of each ROC using the software *RESRAD* Version 7.0 (Argonne National Laboratory, 2014). A conservative resident famer scenario was used, which assumed a full-time resident that grows crops in the modeled area. Radium-226 was corrected for background (0.633 picocurie per gram [pCi/g]) in accordance with Work Plan (CB&I, 2016) Section 5.7, and it was assumed to be in equilibrium with its progeny Lead-210. The other ROCs (^{137}Cs, ^{60}Co, and ^{90}Sr) were not corrected for background in the models.

Other site-specific inputs to the model include a cover of 0.61 m (2 ft) of clean soil, as the Phase III contractor for Parcel E-2 will install this soil layer. The depth of the contaminated layer was set to 0.25 m, and the density of soil was set to 1.68 g/cm^3. The modeled area was set to 1,000 square meters, the size of a SU.

The modeling resulted in a maximum excess lifetime risk that meets the risk management range of 10^{-6} to 10^{-4} for each ROC. Appendix L presents the RESRAD output reports for dose and risk. Table 4 presents the maximum dose and maximum excess lifetime risk for each ROC.

5.0 { AUTOTEXTLIST \s"Break"\t"Right-click to change break type" * MERGEFORMAT }Data Quality Assessment

The following subsections discuss the findings of the data review and validation process for analytical and radiological data.

5.1 Laboratory Data Quality Assessment

Appendix AA presents the laboratory data quality assessment.

5.2 Radiological Data Assessment

The following subsections describe the data quality objectives (DQOs) for radiological data and the radiological data quality assessment.

5.2.1 Data Quality Objectives

DQOs are qualitative and quantitative statements developed to define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose, and specify the performance requirements for the quality of information to be obtained from the data. The DQOs used for this project are summarized in the following subsections.

5.2.1.1 Step One—State the Problem

The HRA (Naval Sea Systems Command, 2004) identifies Parcel E-2 as radiologically impacted; therefore, radiological screening of excavated soil and excavated surfaces will be performed.

5.2.1.2 Step Two—Identify the Decision

The decision to be made is as follows: "Do the survey and sampling results support a conclusion that the residual concentrations of ROCs in Parcel E-2 results in a residual radiological risk at the final ground surface within the risk management range of 10^{-6} to 10^{-4} specified in the NCP (National Contingency Plan)?"

5.2.1.3 Step Three—Identify Inputs to the Decision

Radiological surveys will include the following:

- Soil samples/analytical data
- Gamma scan survey data

5.2.1.4 Step Four—Define the Study Boundaries

The lateral spatial boundary for this study is the project area boundaries, as shown on Figure 5. The vertical boundary of the project area is a minimum of 2.5 feet below the planned finish grade. This depth is the average estimated depth of the deepest cut to meet the subgrade elevation plan provided in the DBR (ERRG, 2014).

5.2.1.5 *Step Five—Develop a Decision Rule*

If the results of the survey are consistent with the release criteria (Table 2) and the ILs, then the data will be used to support a conclusion that the residual concentrations of the ROCs results in a residual radiological risk at the final ground surface within the risk management range of 10^{-6} to 10^{-4}.

If the results of the survey exceed the screening criteria, then the area will be further investigated.

5.2.1.6 *Step Six—Specify Limits on Decision Errors*

Limits on decision errors are set at 5 percent.

5.2.1.7 *Step Seven—Optimize the Design for Obtaining Data*

Operational details for the radiological survey process have been developed, as discussed in Sections 3.2.11 and 3.3.2.

5.2.2 Radiological Data Quality Assessment

Gamma walkover data was reviewed by the radiological support team for completeness prior to analysis. The APTIM Project Radiation Safety Officer reviewed survey data to determine that the data met the appropriate criteria. The Project Radiation Safety Officer also reviewed field logbooks, sample chains-of-custody, and other documentation for accuracy and completeness. Radiological instruments were subjected to response checks and operational checks prior to use. Only instruments that passed these checks were allowed to collect data on a given day. Appendix R includes radiological instrument checks and calibration information.

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6.0 [AUTOTEXTLIST \s"Break"\t"Right-click to change break type" * MERGEFORMAT]Community Relations

Prior to the start of work, the Work Plan (CB&I, 2016) was made available to the public at two local repositories: City of San Francisco Main Library and HPNS Library (located near the entrance to the base).

The Navy creates quarterly newsletters on HPNS projects to keep the public informed. The newsletters are a part of the Navy's ongoing Community Relations efforts; they are mailed to residents and provided to local businesses for public use.

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7.0 [AUTOTEXTLIST \s"Break" \t"Right-click to change break type" * MERGEFORMAT]Conclusions and Ongoing Activities

Conclusions and a discussion of the ongoing activities for this RA are discussed in this section. As mentioned in Section 1.0, the Parcel E-2 remedy is being implemented in ~~three~~ separate phases because of the large scope of required actions as detailed in the DBR (ERRG, 2014). ~~However, as necessary for scheduling and contracting purposes, a few of the final tasks originally designated as Phase III may be separated into a new fourth phase of construction.~~ The task order described within this ~~completion~~construction summary report was the second phase, which included shoreline revetment; site grading and consolidation of excavated soil, sediment, and debris; and upland slurry wall installation. No further action is required for these RA components; however, the ~~Parcel E-2 RA~~Navy plans to prepare a post-remedial action study work plan to evaluate whether the Phase II remedy is operational and functional. This work plan will ~~continue in subsequent phases~~describe the specific tasks needed to conduct ongoing routine performance monitoring, as necessary, to evaluate the performance of the remedy as installed until the full scope of the DBR has been implemented. ~~When~~Once all phases of the Parcel E-2 RA are completed~~,~~ and requirements of the ROD (Navy, 2012) are met, the documentation that the RAOs have been achieved will be ~~met and documented~~presented in the final ~~phase RACR~~remedial action completion report for the site.

7.1 Conclusions

The RAOs listed in Section 2.0 for soil and sediment were achieved for the Phase II RA, as residual chemical and radiological contamination indicated by post-excavation confirmation sampling and screening was removed from within Parcel E-2:

- Approximately 112,873 cy of soil were generated and cleared during Parcel E-2 Phase II activities including:
  - Approximately 51,902 cy of soil, sediment, and debris from the tidal and freshwater wetland
  - Approximately 1,204 cy of material suspected of containing methane-generating debris
  - Approximately 1,782 cy of material exceeding the appropriate hot spot goal for lead
- 179 SUs, encompassing approximately 47.4 acres, were surveyed and sampled to determine as-left conditions
- 337 lifts of excavated soil were radiologically processed (surveyed and sampled) on RSY pads, prior to reconsolidating cleared soil on site
- An estimated 9,754 cy of debris and oversized material (once radiologically cleared) was moved for placement within the assigned waste consolidation area
- Off-site disposal of 2,156 tons of Resource Conservation and Recovery Act soil and 154 tons of Resource Conservation and Recovery Act concrete (Appendix X)
- 42 LLROs were identified and recovered during the project
  - 21 LLROs were found on RSY pads
  - 18 LLROs were found during radiological surveys of the SUs
  - 3 LLROs were found during waste consolidation survey activities

To protect the shoreline from erosion, thus helping to ensure the protection of the completed Parcel E-2 remedy, the shoreline revetment structure was installed in accordance with the DBR (ERRG, 2014) as described within this RACSR.

~~Additionally, the RAOs listed in Section 2.0 for control of groundwater were met through the installation of the upland slurry wall, French drain, and upgradient well network as discussed within this RACR.~~

Further evaluation of the long-term performance of the upland slurry wall and freshwater wetlands will be conducted in accordance with the RAMP for Parcel E-2 (ERRG, 2014), and in the Five-Year Review. In addition, the Navy plans to prepare a post-remedial action study work plan to evaluate whether the Phase II remedy is operational and functional. This forthcoming work plan will describe the specific tasks needed to conduct ongoing routine performance monitoring, as necessary, to evaluate the performance of the remedy as installed until the full scope of the DBR (ERRG, 2014) has been implemented. Once all phases of the Parcel E-2 RA are completed and requirements of the ROD (Navy, 2012) are met, the documentation that the RAOs have been achieved will be presented in the final remedial action completion report for the site.

The shoreline area of Parcel E-2 is adjacent to the San Francisco Bay, which contains contaminated sediments. Contaminated sediments below the mean sea level are to be addressed by the selected remedy for Parcel F, the Navy's property offshore of HPNS (ERRG, 2014). As discussed in Section 3.2.2, an additional excavation 6 feet into Parcel F was completed to assure the integrity of the revetment structure during future remediation activities within the San Francisco Bay.

7.2 Recommendations and Ongoing Activities

Remedial activities should continue in Parcel E-2 following completion of the Phase II activities described within this RACSR. The Phase III RA should include the following:

- Import, place, and compact the estimated 9,277 cy of fill required to complete construction of the foundation layer (Section 4.5), deferred from the Phase II RA; resolved June 11, 2019 during final site inspections with the Navy (Appendix B)
- Install the final upgradient well network surface completions (Section 3.2.15), deferred from the Phase II RA; resolved under Navy approval of FCR-006 (Appendix G).)
- Collect depth-to-water measurements from the nearshore slurry wall piezometers during the next scheduled sampling event in order to verify that the hydraulic gradient across, and the mound height upgradient of, the nearshore slurry wall do not exceed the acceptable limits identified in the DBR (ERRG, 2014)
- Preparation of a post-remedial action study work plan intended to describe the specific tasks needed to conduct ongoing routine performance monitoring to evaluate the performance of the remedy as installed until the full scope of the DBR has been implemented

- Installation of the final cover system (including soil and geosynthetics)
- Final construction and development of the freshwater and tidal wetlands
- Installation and operation of a landfill gas extraction, control, and containment system
- Final installation of site features such as service roads, drainage features, monitoring wells, and perimeter fencing~~; and~~
- ~~Development of a final remedial action completion report, demonstrating that the remedy is complete and meets the RAOs of the ROD (Navy, 2012)~~
- Post-construction operations and maintenance

Phase III, to be completed by another contractor under a separate contract award by the Navy, is expected to be the final phase of the Parcel E-2 RA. Phase III is anticipated to be completed in 2022.

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8.0 [AUTOTEXTLIST \s "Break" \t "Right-click to change break type" * MERGEFORMAT]Certification Statement

I certify that this RACSR memorializes completion of the construction activities to implement the ~~RA~~Work Plan at Parcel E-2 Phase II at HPNS, San Francisco, California specifically ~~1) construction~~ as follows:

- Construction of the shoreline revetment structure~~; 2) excavation~~
- Excavation for the freshwater and tidal wetlands~~; 3) site~~
- Site grading and consolidation of excavated soil, sediment, and debris~~; 4) installation~~
- Installation of the Parcel E-2 upland slurry wall~~; and 5) radiological~~
- Radiological surface scanning, remediation, and clearance of the HPNS Parcel E-2 site~~.~~

The ~~RA was implemented~~construction activities for the site were completed pursuant to the ROD (Navy, 2012) and the DBR (ERRG, 2014), and in accordance with the Work Plan (CB&I, 2016), with deviations noted herein. This RACSR documents the implementation of a portion of the remedy selected in the ROD, specifically the shoreline revetment; site grading and consolidation of excavated soil, sediment, and debris; and upland slurry wall installation. Recommendations and ongoing activities have been presented in detail in Section 7.2 of this ~~RACR. No additional construction activities for this phase of the remedial design are anticipated at this time, thus these portions of the RA are deemed complete.~~RACSR.

Mr. Derek J. Robinson, PE
BRAC Environmental Coordinator
Hunters Point Naval Shipyard

Date

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TABLES

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Table 1: Hot Spot Goals for Soil and Sediment

Hot Spot Tier	Impacted Media	COC/COEC	Hot Spot Goal (mg/kg)	Basis for Hot Spot Goal
Tier 1	Soil	Copper	4,700	10 times RG for terrestrial wildlife [a]
		Heptachlor epoxide	1.9	10 times RG for recreational users [a]
		Lead	1,970	10 times RG for terrestrial wildlife [a]
		Total PCBs	7.4	10 times RG for recreational users [a]
		Total TPH	3,500	TPH source criterion [b]
	Sediment	Copper	2,700	10 times RG for aquatic wildlife [a]
		Lead	2,180	10 times RG for aquatic wildlife [a]
		Total PCBs	1.8	10 times RG for aquatic wildlife [a]
		Total TPH	3,500	TPH source criterion [b]
Tier 2	Soil	Copper	4,700	10 times RG for terrestrial wildlife [a]
		Lead	1,970	10 times RG for terrestrial wildlife [a]
		Total PCBs	7.4	10 times RG for recreational users [a]
		Total TPH	3,500	TPH source criterion [b]
	Sediment	Copper	2,700	10 times RG for terrestrial wildlife [a]
		Lead	2,180	10 times RG for terrestrial wildlife [a]
		Total PCBs	1.8	10 times RG for terrestrial wildlife [a]
		Total TPH	3,500	TPH source criterion [b]
Tier 3	Soil	Lead	19,700	100 times RG for terrestrial wildlife [a]
		Total PCBs	74	100 times RG for recreational users [a]
		Total TPH	3,500	TPH source criterion [b]

Table 1: Hot Spot Goals for Soil and Sediment

Hot Spot Tier	Impacted Media	COC/COEC	Hot Spot Goal (mg/kg)	Basis for Hot Spot Goal
Tier 4	Soil	Copper	4,700	10 times RG for terrestrial wildlife [a]
		Lead	1,970	10 times RG for terrestrial wildlife [a]
		Total PCBs	7.4	10 times RG for recreational users [a]
		Total TPH	3,500	TPH source criterion [b]
		Zinc	7,190	10 times RG for terrestrial wildlife [a]
Tier 5	Soil	Copper	4,700	10 times RG for terrestrial wildlife [a]
		1,1-Dichloroethane	2.8	Residential RBC (for Parcel E) [c]
		Lead	1,970	10 times RG for terrestrial wildlife [a]
		Tetrachloroethene	0.48	Residential RBC (for Parcel E) [c]
		Total TPH	3,500	TPH source criterion [b]
		Trichloroethene	2.9	Residential RBC (for Parcel E) [c]
		Vinyl chloride	0.024	Residential RBC (for Parcel E) [c]

Notes:

[a] Section 9.1.1 of the RI/FS Report (Engineering/Remediation Resources Group, Inc. and Shaw Environmental, Inc., 2011) presents RGs for recreational users, terrestrial wildlife, and aquatic wildlife. Soil goals apply to Parcel E-2 areas except for the intertidal shoreline zone (Figure 2), where sediment goals apply to material from 0 to 2.5 feet below ground surface. The 2.5-foot depth corresponds to the exposure depth for aquatic wildlife that may inhabit the intertidal shoreline zone (as documented in the screening-level ecological risk assessment presented in the RI/FS Report).

[b] TPH source criterion (Shaw Environmental, Inc., 2007). The TPH source criterion represents the most conservative evaluation criterion for potential sources of groundwater contamination that may impact aquatic wildlife in San Francisco Bay, and is selected as the hot spot goal in areas where total TPH is known to be present in groundwater at concentrations exceeding the corresponding RG (Section 9.3.1 of the RI/FS Report).

Table 1: Hot Spot Goals for Soil and Sediment

[c] Residential RBCs for the select VOCs are presented as part of the human health risk assessment for Parcel E (Barajas & Associates, Inc., 2008); these VOCs are present in Parcel E-2 and impact groundwater at Parcel E at concentrations that pose a risk to humans. These RBCs represent the most conservative evaluation criteria and are selected as hot spot goals for the purpose of maximizing the effectiveness of the VOC source removal effort and on the presumption that, based on available site data, the VOC source area is limited in volume (Figure 12-8, of the RI/FS Report).

COC	chemical of concern
COEC	chemical of ecological concern
mg/kg	milligram per kilogram
PCB	polychlorinated biphenyl
RBC	risk-based concentration
RG	remediation goal
RI/FS Report	*Final Remedial Investigation/Feasibility Study Report for Parcel E-2 Hunters Point Shipyard San Francisco, California*
TPH	total petroleum hydrocarbons
VOC	volatile organic compound

Sources:

Barajas & Associates, Inc. 2008. *Final Revised Remedial Investigation Report for Parcel E, Hunters Point Shipyard, San Francisco, California*. May 2

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Table 2: Remediation Goals for Radionuclides in Soil and Sediment

Radionuclide of Concern	Exposure Scenario	
	Outdoor Worker (pCi/g)	Resident [a] (pCi/g)
^{137}Cs	0.113	0.113
^{60}Co [b]	0.252 [c]	0.252 [c]
^{226}Ra	1.0 [d]	1.0 [d]
^{90}Sr	10.8	0.331

Notes:

[a] Residential use is not planned for Parcel E-2, but residential goals are proposed as an additional level of protection.

[b] ^{60}Co is an ROC for the Experimental Ship Shielding Range only.

[c] Remediation goal for ^{60}Co was revised to support efficient laboratory gamma spectroscopy analysis of soil samples. This revised remediation goal maintains morbidity risks within the EPA-defined acceptable range and permits an exposure level that does not increase the risk of cancer from a potential exposure to ^{60}Co.

[d] Remediation goal is 1 pCi/g above background per agreement with EPA (established in "Final Basewide Radiological Removal Action, Action Memorandum – Revision 2006, Hunters Point Shipyard, San Francisco, California," dated April 21, 2006), and is consistent with the radiological-related remedies selected in the records of decision for Parcels B, G, D-1, and UC-1. The ^{226}Ra background level for surface soil is 0.633 pCi/g. The ^{226}Ra background level for storm drain and sewer lines is 0.485 pCi/g.

^{60}Co	cobalt-60
^{90}Sr	strontium-90
^{137}Cs	cesium-137
^{226}Ra	radium-226
EPA	U.S. Environmental Protection Agency
pCi/g	picocurie per gram

Sources:

U.S. Department of the Navy (Navy), 2006, *Final Basewide Radiological Removal Action, Action Memorandum for Hunters Point Shipyard – Revision 2006, Hunters Point Shipyard, San Francisco, California*.

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Table 3: Waste-Consolidation-Comparison Criteria

Chemical of Concern	Comparison Criteria [a] (mg/kg)
Copper	4,700
Lead	1,970
Zinc	7,190
Total PCBs	74
Total TPH	3,500
1,1-Dichloroethane	2.8
Tetrachloroethene	0.48
Trichloroethene	2.9
Vinyl chloride	0.024
Heptchlor epoxide	1.9

Notes:

[a] Waste-consolidation-comparison criterion are based on hot spot goals identified in the Final Record of Decision for Parcel E-2, Hunters Point Naval Shipyard, San Francisco, California (U.S. Department of the Navy, 2012). Excavated waste will be tracked and will be sampled for on-site consolidation for chemicals of concern based on the hot spot tier from which the material originated (i.e., waste may not be sampled for the listed chemicals of concern).

mg/kg milligram per kilogram
PCB polychlorinated biphenyl
TPH total petroleum hydrocarbons

Sources:

U.S. Department of the Navy, 2012, *Final Record of Decision for Parcel E 2, Hunters Point Naval Shipyard, San Francisco, California*, November.

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Table 4: RESRAD Risk Modeling Output Summary

Radionuclide	Maximum Dose (mrem/yr)	Maximum Excess Lifetime Cancer Risk
^{226}Ra	3.963	3.143 E-05
^{137}Cs	5.640 E-03	9.369E-08
^{60}Co	7.822 E-03	6.638 E-08
^{90}Sr	3.497 E-01	3.137 E-06

Notes:

^{60}Co cobalt-60
^{90}Sr strontium-90
^{137}Cs cesium-137
^{226}Ra radium-226
mrem/yr millirem per year

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